Mary Keyt Isham

Oct. 1901, Cincinnati.

MODERN SURGERY

GENERAL AND OPERATIVE

BY

JOHN CHALMERS DACOSTA, M.D.

Professor of the Principles of Surgery and of Clinical Surgery, Jefferson Medical College,
Philadelphia; Surgeon to the Philadelphia Hospital and to
St. Joseph's Hospital, Philadelphia

With 493 Illustrations

THIRD EDITION, REVISED AND ENLARGED

PHILADELPHIA AND LONDON
W. B. SAUNDERS & COMPANY
1900

ELECTROTYPED BY
WESTCOTT & THOMSON, PHILADA.

PRESS OF
W. B. SAUNDERS & COMPANY.

THIS VOLUME IS

DEDICATED, WITH AFFECTIONATE REGARD, TO

DR. ORVILLE HORWITZ,

THE FELLOW-STUDENT, THE HOSPITAL ASSOCIATE, AND
THE TRUSTED FRIEND OF

THE AUTHOR.

PREFACE TO THE THIRD EDITION.

In the preparation of the third edition of this work it has been found necessary to add considerable new matter. This necessity arises from a consideration of just criticisms, from an enlarged experience in teaching, and because there have been important additions to surgical science. The original plan of the work, however, has not been departed from.

1629 Locust Street,
Philadelphia, September, 1900.

PREFACE.

The aim of this Manual is to present in clear terms and in concise form the fundamental principles, the chief operations, and the accepted methods of modern surgery. The work seeks to stand between the complete but cumbrous text-book and the incomplete but concentrated compend.

Obsolete and unessential methods have been excluded in favor of the living and the essential. There has been no attempt to exploit fanciful theories nor to defend unprovable hypotheses, but rather the effort has been to present the subject in a form useful alike to the student and to the busy practitioner.

The opening chapter is devoted to Bacteriology because the author profoundly believes that without some knowledge of the vital principles of this branch of science the vast importance of its truths will be ill-appreciated, and there will be inevitable failure in the application of aseptic and antiseptic methods.

Ophthalmology, gynecology, rhinology, otology, and laryngology have not been considered, because of the obvious fact that in the advanced state of specialized science only the *specialist* is competent to write upon each of these branches.

In Orthopedic Surgery are discussed those conditions which must in the very nature of things often be cared for by the surgeon or the general practitioner (such as hip-joint disease, club-foot, Pott's disease of the spine, flat-foot, etc.). The limited space at command precluded the introduction of a special division on diseases of the female breast. A large amount of space has been devoted to Fractures and Dislocations, the enormous practical importance of these subjects calling for their full discussion. Operative Surgery is considered in separate sections, the most important procedures being fully described, giving also the instruments necessary, and the positions assumed by patient and operator.

This method has been adopted to fit the work for use in surgical laboratories.

Many systems, manuals, monographs, lectures, and journal articles have been consulted, and credit has been given in the text for statements and quotations. Special acknowledgment is due to the *American Text-Book of Surgery*, edited by Keen and White; to the surgical works of Ashhurst, Agnew, the elder Gross, Duplay and Reclus, Esmarch, Albert, Koenig, Wyeth, and Bryant; to the *Manual of Surgery* edited by Treves; to the *International Encyclopædia of Surgery* edited by Ashhurst; to the *Surgical Pathology* of Billroth and of Bowlby; to the *Diagnosis* of A. Pearce Gould; to the *Surgical Dictionary* of Heath; to the *Rest and Pain* of Hilton; to the works on operative surgery of Barker, Jacobson, Treves, Stephen Smith, and Joseph Bell; to the *Minor Surgery* of Wharton; to the dictionary of Foster and of Gould; to the *Principles of Surgery* of Senn; to the orthopedic writings of Sayre; to the work on *Diseases of the Male Generative Organs* of Jacobson; to the *System of Genito-urinary Diseases* edited by Morrow; and to the treatises on *Fractures and Dislocations* of Sir Astley Cooper, Malgaigne, Hamilton, Stimson, and T. Pickering Pick.

The Author returns his thanks to the numerous writers who courteously authorized the reproduction of special illustrations, and particularly to Professors Keen and White for their free permission to draw upon the *American Text-Book of Surgery*, from which a number of pictures have been taken, distinctively those referring to Bandaging; to Mr. John Vansant for the great amount of labor so ably and cheerfully performed; and to Dr. Howard Dehoney for the preparation of the Index.

2050 Locust Street, Philadelphia,
October, 1894.

CONTENTS.

MODERN SURGERY

MODERN SURGERY.

I. BACTERIOLOGY.

BACTERIOLOGY is the science of micro-organisms. Though a science in the youth of its years, bacteriology has not only profoundly altered, but it has also revolutionized, pathology, and our views of surgery would be incomplete, misleading, and erroneous without its aid.

Micro-organisms, microbes, or **bacteria,** are minute non-nucleated vegetable cells of the class *fungi*, many of them being visible only by means of a highly powerful microscope and after they have been brightly stained. The contents of these cells are protoplasm and nuclear chromatin enclosed by a structure containing cellulose. The protoplasm can be stained with anilin colors, and the cell-wall is more readily detected after treating it with water, which causes it to swell. Many microbes are colored, others are colorless. Some move (motile bacteria), others do not move (amotile bacteria); among the motionless ones may be mentioned the bacilli of anthrax and tubercle, and all cocci. Most bacteria can change from motile to amotile or from amotile to motile when subjected to changed conditions of life. The oscillations of cocci are physical and not vital in nature; they are Brunonian or Brownian movements, movements due to alterations in equilibrium because of currents or changes of level in the fluid in which the organisms are held. Bacteria possess the power of attracting elements necessary for their nutrition (positive chemiotaxis or chemotaxis), and of repelling elements antagonistic to them (negative chemiotaxis or chemotaxis).

Definite knowledge of these minute bodies and of their actions dates from the study of fermentation by the celebrated Frenchman Pasteur, who in 1858 asserted that every fermentation has invariably its specific ferment; that this ferment consists of living cells; that these cells produce fermentation by absorbing the oxygen of the substance acted

upon; that putrefaction is caused by an organized ferment; that all organized ferments are carried about in the air; and that entirely to exclude air prevents putrefaction or fermentation. These statements, which were radical departures from accepted belief, inaugurated a bitter controversy, and in that controversy were born the microbic theory of disease, the doctrine of preventive inoculation, antiseptic surgery, and serum-therapy.

The word *microbe*, which signifies a small living being, was introduced in 1878 by the late Professor Sédillot, of Paris. At that time the nature of these bodies was in doubt; some thought them animal, and called them *microzoaria;* others thought them vegetable, and called them *microphyta;* the designation "microbe" does not commit us to either view. We now know them to be vegetable, but the term "microbe" has remained in use.

The micro-organisms connected with disease in man are divided into three classes:

1. Yeasts, Saccharomyces, or Blastomycetes;
2. Moulds, or Hyphomycetes;
3. Bacteria, or Schizomycetes.

Yeasts include most of those fungi which can cause alcoholic fermentation in saccharine matter. They consist of small cells which can live without free oxygen, and which multiply by gemmation or budding. When a cell multiplies a small bud of protoplasm projects from or near the end of the cell. This bud increases progressively in size and a constriction appears between the bud and the parent-cell. The constriction deepens as the projection enlarges, until the bud attains the size of the parent. Thus a chain or series of rounded yeast-cells is formed. These cells contain spores when nourishment is insufficient. The yeasts resemble algæ in many respects, but contain chlorophyll, and are to be regarded as fungi. The chief importance of yeasts is that they cause fermentation; they never invade human tissues, though they can dwell on mucous membranes, and even in the stomach. *Oïdium albicans* is a yeast-fungus whose growth upon the mucous membrane of the mouth, pharynx, and esophagus causes the disease known as "thrush." Pekelharing says that pityriasis is due to the saccharomyces capillitii.

Moulds consist of filaments, each filament being composed of a single row of cells arranged end to end, and all filaments springing from a germinal tube which grows from a germinating spore. Moulds are largely connected with processes

of decay. Some of them grow upon inflamed mucous membrane, and some invade the epidermis, producing certain skin diseases (favus, tinea tonsurans, tinea versicolor, etc.).

Actinomycosis (Fig. 1) and Madura-foot arise from the lodgement and growth of moulds. Actinomycosis is a disease seen in cattle, and occasionally in men, especially in drovers. Cattle become infected usually through their food, the fungus entering by a hollow tooth or by a breach of continuity in mucous membrane. The lower jaw is usually the seat of involvement in cattle (lumpy jaw). A tumor forms, which contains sero-pus, and after a time ruptures and discharges matter containing nodules composed of fungi. The bone may undergo extensive destruction. Other bones and various organs may be infected.

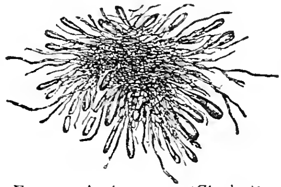


Fig. 1.—Actinomyces (Ziegler).

Madura-foot, or mycetoma, is an endemic disease of India, which is probably due to infection with the chionypha Carteri. The foot swells and becomes covered with pustules; the pustules rupture and expose sinuses; each sinus is lined with a firm membrane and is filled with material which looks like the roe of a fish. The bones are often extensively destroyed, and gangrene not uncommonly arises.

Bacteria chiefly claim our attention. It is important to remember that the term "bacteria," though applied to the class *schizomycetes,* has also a more restricted application—that is, to a division of the class; it may mean either *schizomycetes* in general, or rod-shaped *schizomycetes,* whose length is not more than twice their breadth.

Some of the *schizomycetes* induce certain fermentations; others grow upon dead organic matter, but are not able to invade living tissues, and are called *saprophytes* or non-pathogenic bacteria; still others, known as the *pathogenic,* invade living tissue and cause various diseases. *Parasitic* bacteria can grow on or in the tissues of the body. *Obligate* parasites are those which have not been cultivated outside of the body (as the bacilli of leprosy). *Facultative* parasites usually live outside the body, but may enter into the body and produce disease. The schizomycetes vary much in shape, size, color, arrangement, mode of growth, and action upon the body. One form cannot be transformed into another, but each maintains its specific identity. Every organism comes from a pre-existing organism, this being true

of all forms. Pasteur proved that spontaneous generation is impossible.

Forms of Bacteria.—The three chief forms of bacteria are—

1. The *Coccus* or *Micrococcus*—berry-shaped, oval, or round bacterium (Fig. 2);

2. The *Bacillus*—rod-shaped bacterium (Fig. 3);

3. The *Spirillum*—corkscrew-shaped or spiral bacterium (Fig. 4). A short spiral organism is called a comma bacillus.

FIG. 2.—Micrococcus.

FIG. 3.—Bacillus.

FIG. 4.—Spirillum.

De Bary compares these forms, respectively, to the billiard-ball, the lead-pencil, and the corkscrew.

Cocci and Bacilli.—We have to do only with *cocci* and *bacilli*. Cocci may be designated according to their arrangement with one another; namely, when existing singly they

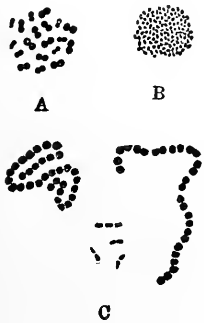


FIG. 5.—Forms of cocci.

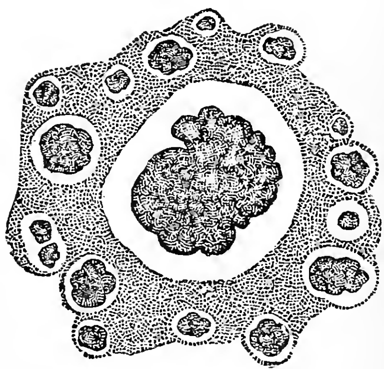


FIG. 6.—Zoöglea (Ball).

are called *monococci;* in pairs they are called *diplococci* (Fig. 5, A); in a chain they are called *streptococci* (Fig. 5, C); in a cluster like a bunch of grapes they are called *staphylococci* (Fig. 5, B); in groups of four they are called *tetracocci;* in groups of eight they are called *sarcina* or *wool-sack* cocci. Irregular masses, resembling frog-spawn, constitute zoöglea masses (Fig. 6). The gelatinous matter in such a mass is

formed by a transformation in the walls of the bacteria. The term *ascococci* is applied to a group of cocci enclosed in a capsule (G. S. Woodhead).

The cocci are often named according to their function, as, for example, "pyogenic," or pus-forming. Cocci may be named according to the color of the culture. The name may embody the form, arrangement, color, and function; for instance, *Staphylococcus pyogenes aureus* signifies a round, golden-yellow micro-organism, which arranges itself with its fellows in the form of a bunch of grapes, and which produces pus.

The *bacilli* are long, staff-shaped organisms. Long, delicate, jointed bacilli having wavy outlines are known as *leptothrix* forms. Chain-like bacilli are called *strepto-bacilli*. Bacilli give origin to many surgical diseases.

Multiplication of Bacteria.—Bacteria multiply with great rapidity when placed under suitable conditions. They can multiply by fission or by spore-formation. Some bacteria multiply by both methods. In fission, or segmentation, the cell elongates and about its middle a constriction begins, which deepens until the cell has divided into two parts, each of which soon grows as large as its parent (Figs. 7, 8).

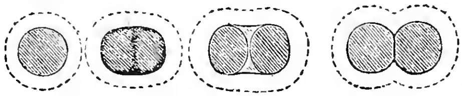


FIG. 7.—Divisions of a micrococcus (after Macé)

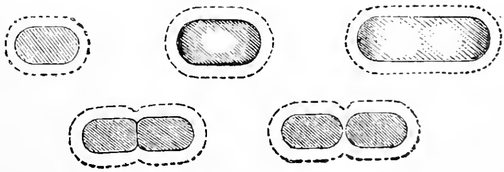


FIG. 8.—Divisions of a bacillus (after Macé).

All cocci and some bacilli multiply by this method. If segmentation of a single cell and the growth to maturity of its products require one hour (it really takes place in less time, the cholera bacillus requiring but twenty minutes to divide), a single cell in a single day, if the conditions for increase are ideally favorable, will have sixteen million descendants, and in three days the mass of new cells would weigh 7500 tons (Cohn). In order, however, for such enor-

mous multiplication to occur conditions would have to be absolutely favorable to the cells, and conditions are never absolutely favorable. Were it otherwise all other forms of life would be destroyed.

Spores.—A *spore* is a germ, and corresponds with the seed of a plant. Most of the bacilli multiply by spore-formation. Cocci do not undergo spore-formation after the manner of bacilli, though some observers maintain that cocci occasionally undergo an alteration that makes them very resistant to any destructive influences (arthrospores). When spore-formation is about to occur in a bacillus points of cloudiness appear in the protoplasm, the cell generally elongates, and in twenty-four hours the cell is found to consist of a series of segments like a necklace of beads, each segment containing a full-grown spore (Fig. 9). The wall of the cell now liquefies, the segments separate, the spores are set free, and each spore under favorable conditions becomes a bacillus. When the initial cloudiness appears in the middle of the cell and but one spore forms, it is called an "endospore;" when it appears at one or both extremities it is christened an "endspore" or "endspores." When multiplication is by a single endospore the bacillus does not elongate. When multiplication takes place by a process of combined spore-formation and fission the mother-cell divides into a number of daughter-cells, which are called arthrospores. Organisms which when active multiply by fission take on spore-formation when subjected to certain conditions.

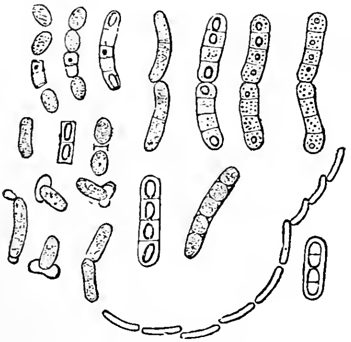


Fig. 9.—Sporulation (after De Bary).

Spore-formation tends to occur when bacilli are about to die for want of nourishment or when there is an excess of oxygen present. Each cell, as a rule, contains but one spore, but may contain several. The spore has a dense envelope or covering which is very resistant to destructive agents. So resistant is the covering that twice the amount of heat is necessary to kill a spore as to kill an active adult cell. Spores when placed under conditions unfavorable for development may remain inactive for an indefinite period, just as

seeds remain inactive when unplanted. When spores encounter favorable conditions they at once develop into adult cells, just as seeds develop when planted. It seems probable that spores occasionally remain dormant in the human body for long periods, and finally awaken into activity because of injury or disease of the tissue in which they lie.

Life-conditions of Bacteria.—In order to grow and to multiply, bacteria require a suitable soil and the favoring influences of heat and moisture. The soil demanded consists of highly organized compounds rather than crude substances, and slight modifications in it may prove fatal to some forms of bacterial life, but highly advantageous to others. Some organisms require albuminous matter, others need carbohydrates; they all require water, carbon, nitrogen, oxygen, hydrogen, and certain inorganic materials, especially lime and potassium (Woodhead). All organisms require water. If dried, no micro-organisms will multiply, and many forms will die. The fluid and tissues of the individual may or may not afford a favorable soil for the germs of a disease, or, in the same person, may afford it at one time and not at another. Some individuals seem to possess indestructible immunity from, and others are especially prone to, certain contagious diseases. Impairment of health, by altering some subtle condition of the soil, may make a person liable who previously was exempt.

The presence of oxygen influences microbic growth. Most organisms thrive best when exposed to the oxygen of the air, and they are known as "aërobic." The term "anaërobic" is employed to designate organisms that can grow and multiply and produce particular products only when air is absent, free oxygen being fatal to them. Tetanus bacilli and the bacilli of malignant edema are anaërobic. An organism which can grow indifferently where oxygen is abundant or where free oxygen is absent is called a "facultative-aërobic" bacterium. It may need oxygen; but if it does, it is able to obtain it from the tissues when air is excluded. A sensitive organism which dies when the amount of oxygen is even slightly diminished is called an "obligate-aërobic" bacterium. Most microbic diseases in man are due to facultative-aërobic bacteria.

Effect of Motion, Sunlight, Heat, and Cold.—The majority of *fungi* grow best when at rest; agitation retards the growth of some and kills others. Sunlight antagonizes the growth of certain bacteria, especially tubercle bacilli and the bacilli of typhoid fever. Temperature influences bacte-

rial growth. Some organisms will only grow within narrow temperature-limits, while others can sustain sweeping alterations, but most grow best between the limits of from 86° to 104° F. Freezing renders bacteria motionless and incapable of multiplication, but it does not kill them: they again become active when the temperature is raised. The absurdity of employing cold as a germicide is evident when the fact is known that a temperature of 200° F. below zero is not fatal to germ-life, cell-activities by such a temperature only being rendered dormant. High temperatures are fatal to bacteria; moist heat is more destructive than dry heat, and adult cells are more easily killed than spores. A temperature less than 212° F. will kill many organisms, and boiling will kill every pathogenic organism that does not form spores. Some spores are not destroyed after prolonged boiling, and some will withstand a temperature of 120° C. As a practical fact, however, boiling water kills in a few minutes all cocci, most bacilli, and all pathogenic spores; though the spores of anthrax, tetanus, and malignant edema are harder to kill than are the spores of other bacteria.

Chemical Antiseptics and Germicides.—It is necessary to make a distinction between deodorizers, antiseptics, and germicides.

A deodorizer is an agent which destroys an offensive odor. It is true that an offensive odor may be due to microbic growth. It is also true that nasty odors may prove injurious to those who inhale them. But, nevertheless, the odor is the result of microbic action, and destroying an odor does not render harmless the bacteria which caused it. Charcoal is a well-known deodorizer.

An antiseptic is an agent which retards or prevents putrefaction. It acts by weakening or killing saprophytic organisms.

A germicide or disinfectant is an agent which is fatal to bacteria. The destruction of the germs of disease in clothing, in excreta, in a wound, etc., is known as disinfection. Disinfection of a wound, dressings, or instruments is called also sterilization.

Many chemical agents will kill bacteria, the most certain of them all being corrosive sublimate. Koch showed that corrosive sublimate is an efficient test-tube germicide when present in the proportion of only 1 part to 50,000. It is used in surgery in strengths of 1 part of the salt to 1000, 2000, 3000, or more parts of water. Badly infected wounds are occasionally irrigated with solutions of a strength of 1 to

500. Contact with albumin precipitates from a solution of corrosive sublimate an insoluble albuminate of mercury which forms upon the surface of the wound, is not a germicide, and prevents deep diffusion of the mercurial fluid. In surgical operations by the antiseptic method the mercurial salt should be combined with tartaric acid in the proportion of 1 to 5, which combination prevents the formation of the insoluble albuminate of mercury.

But though corrosive sublimate under certain conditions is very powerful, it is not always absolutely reliable. Many spores are very resistant to its action. Even a 1 per cent. solution of bichlorid of mercury is not certainly destructive of the spores of anthrax. Geppert tells us that anthrax-spores may be active after a 25-hour immersion in a 1 : 100 solution of sublimate (Schimmelbusch). In the presence of hydrogen sulphid corrosive sublimate is useless, inert and insoluble sulphid of mercury being precipitated; hence corrosive sublimate is without value as a rectal antiseptic; in fact, Gerloczy has proved that a concentrated aqueous solution of sublimate will not disinfect an equal quantity of feces. Corrosive sublimate contained in dressings after a time undergoes decomposition and ceases to be a germicide. It is not germicidal in fatty tissues because it is unable to attack bacteria which are coated with oil. Corrosive sublimate is very irritating to the tissues and causes copious exudation. Hence, after tissues have been irrigated with this agent drainage must be employed. In some cases the irritated tissues lose to a great extent their power of resistance, and infection may be actually facilitated by irrigation with sublimate. In rare instances corrosive sublimate is absorbed and produces poisoning. In spite of these shortcomings and drawbacks it is a valuable aid to the surgeon and must be frequently used, especially upon the skin of the patient and the hands of the operator and his assistants. It should be dissolved in distilled water, because ordinary water causes a precipitate to form (common salt prevents the formation of this precipitate).

Because of the fact that corrosive sublimate is poisonous and very irritant, it should not be used upon serous membranes. It is absorbed quickly from serous membranes and destroys the endothelial cells, and should not be introduced into the pleural sac, into joints, or into the peritoneal cavity. It should never be put within the dura, and should not be applied, in strong solution at least, to mucous membranes. It is better to make the solution when it is needed, so

as to have it fresh, for in old solutions much of the soluble corrosive sublimate has been converted into insoluble oxychlorid, and the fluid has ceased to be germicidal. In order to make up fresh solutions use tablets, each of which contains about $7\frac{1}{2}$ grains of the drug—one of these tablets added to a pint of water makes a solution of a strength of 1 to 1000. Tablets which also contain ammonium chlorid are more soluble than those which contain corrosive sublimate only. Hot solutions of the drug are more powerfully germicidal than cold solutions. As corrosive sublimate is irritant, leads to profuse exudation, and may produce tissue-necrosis, it should never be introduced into an aseptic wound. In such a wound it can do no good and may do much harm.

Griffin, in Foster's *Practical Therapeutics*, sets forth the strengths of solutions applicable to different regions:

For disinfection of the surgeon's hands and the patient's skin, 1 : 1000; for irrigating trivial wounds, 1 : 2000; for irrigating larger wounds and cavities, 1 : 10,000 to 1 : 5000; for irrigating vagina, 1 : 10,000 to 1 : 5000; for irrigating urethra, 1 : 40,000 to 1 : 20,000; for irrigating conjunctiva, 1 : 5000; for gargling, 1 : 10,000 to 1 : 5000.

Instruments cannot be placed in corrosive sublimate without being dulled, stained, and corroded.

Corrosive sublimate may be absorbed from a wound, a serous surface, or a mucous membrane, ptyalism and diarrhea resulting. The absorption of bichlorid of mercury may be followed by cramp in the limbs and belly, feeble pulse, cold skin, extreme restlessness, and even collapse and death. At the first sign of trouble withdraw the drug and treat the ptyalism (page 257).

Carbolic acid is a valuable germicide in the strength of from 1 : 40 to 1 : 20. It is certainly fatal to pus-organisms, but weak solutions do not destroy spores. Unfortunately, this acid attacks the hands of the surgeon; consequently in the United States it is chiefly employed as an antiseptic medium in which to place the sterilized operating-instruments, or as a germicide to prepare the skin of the patient before the operation is performed.

Carbolic acid is very irritant to tissues, and carbolized dressings may be responsible for sloughing of the wound or dry gangrene. Because of its irritant properties wounds which have been irrigated with it should be well drained. Carbolic acid, like corrosive sublimate, is inert in fatty tissues. Carbolic acid is readily absorbed, and may thus produce toxic symptoms. Absorption is not uncommon when

the weaker solutions are used, but rarely occurs when a wound has been brushed over with pure acid, because the pure acid at once forms an extensive zone of coagulation, which acts as a barrier to absorption. One of the early indications of the absorption of carbolic acid is the assumption by the urine of a smoky, greenish, or blackish hue. This hue appears a little time after the urine has been voided, whereas the smoky hue of hematuria is noted in urine at once after it has been passed. The condition produced by carbolic acid is known as carboluria, and examination of such urine shows a great diminution or entire absence of sulphates when the acidulated urine is heated with chlorid of barium. The diminution of precipitable sulphates is explained by the fact that these salts are combined with carbolic acid, forming soluble sulphocarbolates (Griffin). Such urine is apt to contain albumin. If during the use of carbolized dressing or the employment of carbolic solutions the urine becomes smoky, the use of the drug in any form must be at once discontinued, otherwise dangerous symptoms will soon appear. These symptoms are subnormal temperature, feeble pulse and respiration, muscular weakness, and vertigo. If death occurs, it is due, as a rule, to respiratory failure. The treatment of slow poisoning by carbolic acid consists in at once withdrawing the drug, giving stimulants and nourishing food, administering sulphate of sodium several times a day and atropin in the morning and evening.

Pure carbolic acid is a reliable disinfectant for certain conditions. It is used to destroy chancroids, to purify infected areas, to disinfect the medullary cavity in osteomyelitis, to stimulate granulation after the open operation for hydrocele or to purify sloughing burns. The pure acid rarely produces constitutional symptoms, but it occasionally causes sloughing. Its application causes pain for a moment only, and then analgesia ensues. Even dilute solutions of carbolic acid greatly relieve pain when applied to raw surfaces.

Carbolic acid is certainly fatal to but few bacteria and it fails to kill most spores. It acts more slowly and less certainly than corrosive sublimate. It requires twenty-four hours for a 5 per cent. solution to kill anthrax-spores. Pus or blood (albuminous matter) greatly weakens the germicidal power of carbolic acid, and fatty tissue cannot be disinfected by it. It is not even the best of agents in which to place instruments, as it dulls them. After operation upon the mouth it is used as a wash or gargle, 1 to 2 per cent. being a suitable strength. It is used sometimes to irrigate the bladder and

often to cleanse sinuses, but is not employed in the peritoneal cavity, the pleural sac, or the brain. It is occasionally injected into tubercular joints.

Creolin, which is a preparation made from coal-tar, is a germicide without irritant or toxic effects. It is less powerful than carbolic acid, but acts similarly, and is used in emulsion of a strength of from 1 to 5 per cent., and does not irritate the skin like carbolic acid.

Peroxid of hydrogen is an excellent agent for cleansing a purulent or putrid area. It comes in a 15-volume solution, which should be diluted one-half or two-thirds. It probably destroys the albuminous element upon which bacteria live, and starves the fungi. When peroxid of hydrogen is applied to a purulent area ebullition occurs, liberated oxygen bubbling up through the fluid and the pus being oxidized. The peroxid of hydrogen is not fatal to tetanus bacilli; in fact, tetanus bacilli can be cultivated in a strong solution of it. Some surgeons use it to wash out appendicular abscesses. It must not be injected into a deep abscess in any region unless a large opening exists, as otherwise the evolved gas may tear apart structures and dissect up the cellular tissue. In a deep abscess of the neck the author saw this agent almost produce suffocation, the gas passing under the mucous membranes and nearly blocking the air-passages. Peroxid of hydrogen should not be applied to an aseptic wound. The use of peroxid should not be too long continued, for if used for a considerable period it makes the granulations edematous and retards healing. In fact, its continued use may actually prevent a sinus closing.

Iodoform is largely used; it is not truly a germicide, as bacteria will grow upon it, but it hinders the development of bacteria and directly antagonizes the action of the toxic products of germ-life. It can be rendered sterile by washing with a solution of corrosive sublimate. It is of the greatest value when applied to infected areas and tubercular processes. Clinically, no real substitute for it has yet been found. It need not be applied to clean wounds, but the powder is very useful when dusted into infected wounds. It prevents wound-discharges from decomposing and distinctly allays pain. Gauze impregnated with iodoform is used to keep abscesses open after evacuation, to drain the belly after certain operations, to pack aside the intestines and prevent their infection during some abdominal operations, and as packing to arrest intracranial hemorrhage. Iodoform gauze will drain serum well, but will not drain pus.

In fact, it blocks up a pus-cavity, and if retained long leads to the collection of purulent matter behind and about the supposed drain. If used in an abscess, it must be removed in twenty-four or thirty-six hours. Tubercular joints and cold abscesses are injected with iodoform emulsion, which is made by adding the drug to sterile glycerin or olive oil. The emulsion contains 10 per cent. of iodoform. A solution in ether of a strength of 10 per cent. may be used to inject the cavity of a cold abscess.

The drug must be used with some caution. Absorption from a wound sometimes happens, producing toxic symptoms. These symptoms are frequently misinterpreted, being usually attributed to infection. The symptoms in some cases are acute and arise suddenly, and consist of a hallucinatory delirium, nausea, fever, watery eyes, contracted pupils, metallic taste in mouth, yellowness of the skin and eyes, an odor of iodoform upon the breath, the presence of the drug in the urine, the outbreak of a skin eruption resembling measles, and excessive loss of flesh and strength. Patients with such acute symptoms usually pass into coma and die within a week. Such attacks are most apt to arise in those beyond middle life (see Gerster and Lilienthal, in Foster's *Practical Therapeutics*). Iodin can be recognized in urine by adding a few drops of commercial nitric acid and a little chloroform. When the mixture is shaken the chloroform will take up the free iodin and become purple, and on standing the purple layer will settle to the bottom of the tube. In chronic cases of iodoform-poisoning the first symptoms usually observed are moroseness, bewilderment, and irritability, followed by depression with unsystematized persecutory delusions, delirium, coma, and even death.

In systemic poisoning by iodoform, discontinue the use of the drug and sustain the strength of the patient while nature is removing the poison.

Iodoform sometimes produces great local irritation of the cutaneous surface, shown by crops of vesicles filled with turbid yellow serum or even bloody serum. These vesicles rupture and expose a raw oozing surface, looking not unlike a burn. The use of the drug must be at once abandoned, for to continue it will not only increase the dermatitis, but will produce constitutional symptoms. Wash the vesiculated area with ether to remove iodoform, open each vesicle and dress the part for several days with gauze wet with normal salt solution. After acute inflammation ceases apply zinc ointment or cosmolin.

Europhen is a powder containing iodin, and the iodin separates from it slowly when the powder is applied to wounds or ulcers. It does not produce toxic symptoms readily, if at all, and is a valuable substitute for iodoform. It is used especially in the treatment of ulcers and burns.

Nosophen is a pale yellow powder containing 60 per cent. of iodin. Its bismuth salt is known as **antinosin.** Nosophen is not toxic, is free from odor, and is the best of the substi-stutes for iodoform.

Acetanilid is frequently used as a substitute for iodoform. It is of value when applied to suppurating, ulcerating, or sloughing areas, but it does not benefit tubercular conditions. Sometimes absorption takes place to a sufficient extent to cause cyanosis, sweating, and weakness of the pulse and respiration. If cyanosis arises, suspend the administration of the drug and administer stimulants by the stomach.

Silver is a valuable antiseptic. Halsted and Bolton have shown that metallic silver exerts an inhibitive action upon the growth of micro-organisms and does not irritate the tissues. Credé has demonstrated the same facts. These statements indicate one great reason why silver wire is so useful as a suture-material. Halsted is accustomed to place silver foil over wounds after they have been sutured, and Credé employs as a dressing a fabric in which metallic silver is intimately incorporated.

Credé considers silver lactate (**actol**) an admirable antiseptic. It does not form an insoluble albuminate when introduced into the tissues and is not an irritant. Silver citrate (**itrol**) is said to be even a better preparation than silver lactate, and it is a useful dusting-powder.

Formaldehyd, or **formic aldehyd,** has valuable antiseptic properties. **Formalin** is a 40 per cent. solution of the gas in water. Solutions of this strength are very irritant to the tissues, but 2 per cent. solutions can be used to disinfect wounds. The stronger solution is valuable for asepticizing chancroids and other ulcers. The milder solution is used to irrigate sinuses, tubercular areas, abscess-cavities, and suppurating joints. The vapor of formalin is used to disinfect wounds, and Wood suggests its employment in septic peritonitis as a means of disinfection after the abdomen has been opened. A 2 per cent. solution disinfects instruments satisfactorily.

Formalin-gelatin has recently been introduced by Schleich as an antiseptic powder. When applied to a clean wound it gives off formalin and keeps the wound aseptic. When it is

applied to a sloughing surface it will not give off formalin unless it is mixed with pepsin and hydrochloric acid. The commercial preparation is known as **glutol**. Formalin-gelatin has been used to replace bone-defects.

Nucleins, especially protonuclein, possess germicidal powers. Protonuclein is of value in treating areas of infection, particularly when sloughing exists.

Among other antiseptics and germicides of more or less value we may mention trichlorid of iodin, iodol, chlorid of zinc, chlorid of iron, loretin, salol, oxycyanid of mercury, fluorid of sodium, argonin, sugar, mustard, lannaiol, bichlorid of palladium (in very dilute solution), thymol, potash soap, iodin, salicylic acid, boric acid, camphor, eucalyptol, cinnamon, bromin, chlorin (as gas or as chlorin-water), cinnamic acid, permanganate of potassium or of calcium, chlorate of potassium, alcohol, normal salt solution, and oxalic acid.

The best germicide is heat, and the best form in which to apply heat is by means of boiling water (even better than steam). One can use boiling water upon instruments and dressings, but rarely upon a patient. Jeannel, of Toulouse, uses boiling salt solution in abscess-cavities, and some other surgeons employ steam or boiling water to disinfect the medullary canal in osteomyelitis. Nevertheless, boiling water is rarely applied to the patient, and in many cases a chemical germicide must be used. The surgeon should always scrub his hands in a germicidal solution, and corrosive sublimate is one of the best we possess.

Distribution of Bacteria.—Microbes are very widely distributed in nature. They are found in all water except that which comes from very deep springs; in all soil to the depth of three feet; and in air, except that of the desert, that over the open sea, and that of lofty mountains.

Microbes may be useful. Some of them are scavengers, and clean the surface of the earth of its dead by the process known as "putrefaction," in which complex organic matter is reduced to harmless gases and to a mineral condition. The gases are taken up from the air by vegetables, and the mineral matter is dissolved in rain-water and passes into the soil from which it came, there again to be food for plants, which plants will become food for animals. Other organisms purify rivers; others cause bread to rise; still others give rise to fermentation in liquors. Microbes may be harmful. They may poison rivers and soils; they may be parasites on vegetable life; they cause diseases of the growing vine, and also of wine; they produce the mould on stale,

damp bread; they occasionally form poisonous matter in sausages, in ice-cream, and in canned goods; and they produce many diseases among men and the lower animals.

With so universal a distribution of these *fungi*, man must constantly take them into his organism. They are upon the surface of his body, he inhales them with every breath, and he swallows them with his food and drink. Most of them, fortunately, are entirely harmless; others cannot act on the living tissues; but some are virulent, and these are generally but not always destroyed by the cells of the human body. The alimentary canal always contains bacteria of putrefaction, which act only upon the dead food, and not upon the living body; but when a man dies these organisms at once attack the tissues, and post-mortem putrefaction begins in the abdomen.

Koch's Circuit.—To prove that a microbe is the cause of a disease it must fulfil Koch's circuit. It must always be found associated with the disease; it must be capable of forming pure cultures outside the body; these cultures must be capable of reproducing the disease; and the microbe must again be found associated with the artificially produced morbid process.

Disease-production. — Disease-producing organisms which enter the body are usually rapidly destroyed. They cannot dwell there long without inducing disease, but spores can lie dormant in the system for years, only waking into activity when they come in contact with some damaged, weakened, or diseased part where the circulation is abnormal —a so-called point of least resistance (a *locus minoris resistentiæ*)—which affords a nest for them to develop and to multiply, the cellular activities of the weakened part being unable to cope with the activities of the germs. Even large numbers of pathogenic organisms may induce no trouble in a healthy man; but let them reach a damaged spot, and mischief is apt to arise. Kocher established subcutaneous bone-injuries in dogs, and these injuries pursued a healthy course until the animal was fed upon putrid meat, whereupon suppuration took place. This experiment proves that an organism can reach a damaged area by means of the blood, and it enables us to understand how a knee-joint can suppurate when we merely break up adhesions, and how osteomyelitis can follow trauma when the skin is intact. A given number of organisms might produce no effect on a healthy man, whereas the same number might produce disease in an individual who was weak or ill-nourished, suffering from depres-

sion or fear, or debilitated by the habitual use of alcohol. The personal increment plays a great part in disease-production. Some individuals seem to be immune to certain diseases; others seem especially liable to develop certain diseases; and these immunities and liabilities may be hereditary or acquired, temporary or permanent.

Toxins.—The action of pathogenic bacteria upon the tissues is of great importance. In the first place, they abstract from the blood, the lymph, and the cells certain elements necessary to the body—as water, oxygen, albumins, carbohydrates, etc.—and thus cause body-wasting and exhaustion from want of food. In the second place, bacteria produce a vast number of compounds, some harmless and others highly poisonous. The symptoms of a microbic disease are largely due to the absorption of poisonous materials from the area of infection. These poisons may be formed from the tissues by the action upon them of the bacteria (toxins and peptones) or may be liberated from the bodies of degenerating microbes (bacterial proteid). Bacteria contain and secrete ferments like pepsin or trypsin, and as albumoses are formed in the alimentary canal by the action of digestive ferments upon proteids, sugars, and starches, so microbic albumoses are formed by the action of microbic ferments upon tissues. Just as the albumoses formed in digestion are poisonous when injected, so the albumoses of microbic action are poisonous when absorbed. The albumoses of microbic action are called "toxalbumins," and these albumoses often operate as virulent poisons to the body-cells.

A number of compounds formed by the microbic destruction of tissue are alkaloidal in nature. These poisonous alkaloids are readily diffusible and, many of them, very virulent. It is probable that every pathogenic organism has its own special toxin which produces its characteristic effects, although the effects are modified by the nature of the soil—that is to say, by the condition of the tissues. The absorption of toxins may be very rapid; for instance, the toxins of cholera may kill a man before the bacillus has migrated from the intestine. Brieger uses the term *toxin* to designate all of the poisonous products of bacterial action. He divides toxins into alkaloidal or crystallizable and amorphous, the latter being called toxalbumins.

Ptomaïns.—By many writers the term "ptomaïn" is used to designate these toxins, but in reality a ptomaïn is a form of toxin that is due to the action of saprophytic bacteria. A ptomaïn is a putrefactive alkaloid, and a toxin is

any poison of microbic origin. Among these putrefactive alkaloids may be mentioned tetanin, typhotoxin, sepsin, putrescin, tyrotoxicon, muscarin, and spasmotoxin. The poison which occasionally forms in cheese, ice-cream, sausage, and canned goods is composed of ptomaïns. Poisoning by any putrid food is called ptomaïn-poisoning.

Leucomaïns must not be confounded with the above-mentioned bodies. Leucomaïns are alkaloidal substances existing normally in the tissues, and arising from physiological fermentations or retrograde chemical changes. They are natural body-constituents, in contrast to toxins, which are morbid constituents. Leucomaïns are found in expired air, saliva, urine, feces, tissues, and the venom of serpents. If not excreted, these bodies may induce illness, and when injected may act as poisons. Ordinary colds and some fevers result from leucomaïns; they play a great part in uremia, and when excretion is deficient the retained leucomaïns make the system a hospitable host for pathogenic bacteria. Sickness due to the retention and absorption of leucomaïns is known as *autointoxication*. Among leucomaïns may be mentioned adenin, hypoxanthin, and xanthin, allied to uric acid, and other substances allied to creatin and creatinin. The surgeon should never forget the possibility of harm being done by retained leucomaïns, and should endeavor to prevent autointoxication in all cases by keeping the skin, the bowels, and the kidneys active.

Alexins and Antitoxins.—Another group of substances which may arise from microbic action are known as "antitoxins." When a person suffers from a bacterial malady the toxins of the bacteria, by acting upon the body-cells, especially upon the leukocytes, cause the body-cells to produce a product which may kill the bacteria (alexin) or may simply antagonize the toxin (antitoxin). It is taught by some that these materials may exist in blood-serum as leucomaïns, or may be toxins or toxalbumins absorbed by the blood from an area of bacterial disease. It is a well-recognized fact in fermentation that after a time the process ceases, and the addition of more ferment is void of result. The same is true of specific maladies; thus, if a person recovers, the organisms disappear and the injection of more of them produces no result; in other words, immunity exists toward the disease. This immunity was long believed to arise from the exhaustion of some unknown constituent of tissue necessary to the life of the bacteria. It is now believed to be due partly to the capacity of the body-cells

to destroy germs, and partly to the production of alexins or antitoxins, which, when they have developed in sufficient amount, destroy the bacteria or render bacterial products harmless. In other words, bacteria not only produce poisons, but also the antidotes for them. Roux maintains that an antitoxin is not derived from a toxin, but that a toxin stimulates the body-cells to secrete an antitoxin. He further shows that an antitoxin does not destroy a toxin, but acts upon the body-cells and renders them capable of withstanding the poison. Buchner believes that the reason the leukocytes help to ward off disease is not because they act as phagocytes to bacteria, but because they furnish defensive proteids (alexins or antitoxins). Vaughan and others have proved that blood-serum is germicidal; that the germicidal agent is dissolved in the alkaline serum; that this agent is a nuclein which is furnished by the white cells, and this nuclein may be extracted and used therapeutically. Many observers are endeavoring to find the antitoxin of each microbic disease for the purpose of applying it therapeutically. Great claims are made as to the value of the antitoxins of diphtheria, tetanus, and suppurations.

Phagocytes.—The tendency of the white blood-cells, and in a less degree of the endothelial cells of the vessels, to destroy organisms is undoubted. This process of destruction is known as "phagocytosis," and the destroying cells are called "phagocytes." When infection occurs the white blood-cells gather in enormous numbers at the seat of disease, encompass and surround the bacteria, and build a barrier to prevent dissemination of the microbes and general infection of the organism. The force which draws leukocytes to a region of infection, also tends to draw them to an area where there is cellular degeneration or death. This force is called positive chemiotaxis. In very virulent infections the leukocytes may fail to collect and may actually be repelled and scattered under the influence of what has been called negative chemiotaxis. Phagocytes at the seat of infection try to eat up, carry away, and destroy bacteria. A battle-royal occurs, the microbes fighting the body-cells with most active ferments; the body-cells endeavoring to devour and destroy the bacteria (Fig. 10). In some cases the bacteria win absolutely and the patient dies. In other cases they win for a time and overwhelm the organism; but presently the body-cells, whose movements were inhibited by the poison, regain their activity and successfully recur to the attack. It is probable that the ferments thrown out by

the white cells tend both to kill bacteria and to neutralize their toxic products. Those which kill bacteria are known as alexins, and those which neutralize toxic products are known as antitoxins. After the attack of disease has passed away the body-cells have been educated to withstand this poison, and new cells in the future retain this capacity; the weak cells were killed, the fittest survived. The new cells formed by the organism are insusceptible to the poison and the individual is said to be immune. This insusceptibility, or *immunity*, lasts for a varying period. Some persons seem, from birth, immune to certain maladies. The theory of phagocytosis immunity assumes an educated white cor-

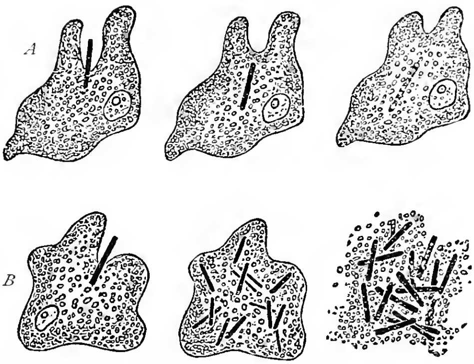


Fig. 10.—Phagocytosis: *A*, successful; *B*, unsuccessful (Senn).

puscle and body-cell. This view originated with Sternberg, but it is usually accredited to Metschnikoff. Lankester gave us the term "educated corpuscle."

Protective and Preventive Inoculations. — Our knowledge of protective inoculations for contagious diseases dates from Jenner's discovery in 1796. Preventive inoculations with attenuated virus are due to the experiments of Pasteur. This observer discovered the cause of chicken-cholera, and cultivated the micro-organism of this disease outside the body. He found that by keeping his cultures for some time they became attenuated in virulence, and that these attenuated cultures, inoculated in fowls, caused a mild attack of the disease, which attack was protective, and rendered the fowl immune to the most virulent cultures. Cultures can be attenuated by keeping them for some time, by exposing them for a short period to a temperature just below that necessary to kill the organisms,

or by treating them with certain antiseptics. It has further been shown that injection of the blood-serum of an animal rendered immune by inoculation is capable of making a susceptible animal also immune.

A most important fact is that animals may be rendered immune to certain diseases by inoculating them with filtered cultures of the microbes of the disease, the filtrate containing microbic products, but not living microbes. By this method animals can be rendered immune to tetanus and diphtheria. Pasteur's protective inoculations against hydrophobia owe their power to microbic products, and Koch's lymph contains them as its active ingredients. The chief feature in acquired immunity is the presence in the blood and tissues of elements which can neutralize the toxic products of or which can kill bacteria. These elements are "antitoxins" and "alexins." The knowledge of them arose from the discovery of Nuttall and Buchner that fresh blood-serum is germicidal, the power varying for different bacteria and being limited. A fixed amount of serum is capable of destroying a fixed number of bacteria only. It has been said that in tetanus injections of the serum of an immune animal may cure the disease. The above facts are of immense importance, for on these lines may be solved the problems of the prevention and treatment of microbic maladies.

Orrhotherapy, or serum-therapy, is an attempt to utilize therapeutically the germicidal properties of blood-serum. It is believed that when a man gets an infectious disease the toxins act upon the body-cells and cause the formation by these cells of defensive proteids, alexins, curative nucleins, or antitoxins. These products enable the body-cells to withstand further injury by the toxins, the disease comes to an end, the bacteria die, and the alkaline blood-serum is saturated with protective material. If the above facts are true, it is an easy deduction that blood-serum containing protective material should cure the disease if injected into a patient suffering from an attack. Instead of using the blood-serum itself, some observers have precipitated the curative nuclein from the serum, and used the nuclein in solution in fixed amounts. Instead of using the serum of persons rendered immune by an attack of the disease, many physicians have employed the serum of animals rendered artificially immune by injections of attenuated cultures of the bacteria. Some experimenters have employed even the serum of animals naturally immune to the disease. That Pasteur has devised a method which will usually prevent hydrophobia is certain

(page 233), and that Murri, of Bologna, has cured a case of hydrophobia seems proved (page 234). Hosts of observers believe in the utility of tetanus antitoxin and diphtheria antitoxin.

Inconclusive experiments have been made in the treatment of syphilis by the serum of dog's blood, and by the blood-serum of men laboring under tertiary syphilis; in the treatment of pneumonia with the blood-serum of persons convalescent from pneumonia; and in the treatment of sufferers from septic diseases with antistreptococcic serum—blood-serum of animals rendered immune to septic infections. Malignant tumors (both sarcomata and carcinomata) have been treated with the blood-serum of dogs, which animals had been injected with fluid expressed from malignant growths (Richet and Hericourt.) Many claims made for serum-therapy in surgical diseases are exaggerated, sensational, and unscientific. That there is truth in the method seems highly probable, but how much of it is true is not yet definitely ascertained. It is our duty to study, experiment, and observe, and to reach a conclusion only after honest, careful, and thorough investigation. A little skepticism is as yet a safe rule.

Antagonistic Microbes.—Another observation of importance is that certain microbes are antagonistic to one another. The streptococcus of erysipelas attacks the organism of anthrax, and is antagonistic to several infectious diseases (syphilis and tuberculosis), also to sarcoma. We should note also that the growth of some microbes affects culture-media favorably or otherwise for the growth of other organisms, and the same may be true in the tissues of the human body. It is not yet proper to endeavor to cure a microbic disease by inoculating antagonistic microbes, on the principle of sending a thief to catch a thief.

Mixed Infection.—A fact of practical importance to the surgeon is that an area infected by one form of pathogenic organism may be invaded by another form. This is known as a *mixed* infection, and consists of a *primary* infection with one variety of organism, and a *secondary* infection with another, or in an infection at the same time with different micro-organisms. Koch found both bacilli and micrococci in the same lesion of tubercle. A soil filled with pneumococci favors the growth of pus cocci and tubercle bacilli. Tubercular or syphilitic lesions may be attacked by erysipelas. Chancre and chancroid can exist together. A syphilitic ulcer is a good culture-soil for tubercle bacilli

(Schnitzler). Suppuration in lesions of tuberculosis is due to secondary infection with pus organisms.

Placental Transmission.—The direct transmission of bacteria from parent to fetus is a problem still in course of solution. Certain it is that some diseases (as syphilis) are due to the direct carrying of the microbes by sperm-cell to germ-cell, or to the transmission of the micro-organism through the septum of separation between the circulations of the mother and child. In many other diseases the microbe is not directly transmitted (as in phthisis), but a patient born with weakened tissue-cells is prone to fall a prey to the latter malady.

Special Surgical Microbes.—Suppuration is caused by microbes. Can it exist without them? The answer is, No. Injection of a fluid containing dead organisms will form a limited amount of pus; injection of an irritant forms a thin fluid which may resemble pus, but which is not pus. In surgery pus is not met with without the micro-organisms, and the presence of pus proves the presence of micro-organisms. *Pus microbes*, or *pyogenic microbes*, possess the property of peptonizing albumin, and thus forming pus. The peptonizing action is brought about by bacterial proteids, or ferments. The inflammation which surrounds an area of pyogenic in-

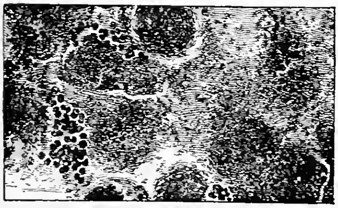


FIG. 11.—Staphylococcus pyogenes aureus in pus (× 1000) (Fränkel and Pfeiffer).

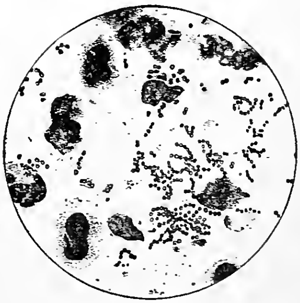


FIG. 12.—Streptococcus pyogenes in pus (× 1000) (Fränkel and Pfeiffer).

fection is caused by the irritant products of bacterial action (toxalbumins, ammonia, etc.). In the presence of the pyogenic peptones the coagulation of inflammatory exudate is retarded or prevented. The most usual causes of suppuration are the following micro-organisms:

Staphylococcus pyogenes aureus (Plate 1, Fig. 1, and Fig. 11), the golden-yellow coccus. This is the most usual cause of abscesses (circumscribed suppurations); 77 per cent. of acute

abscesses are due to staphylococci (W. Watson Cheyne). Staphylococci are found also in osteomyelitis. The staphylococcus pyogenes aureus is a facultative anaërobic parasite which is widely distributed in nature, and is found in the soil, the dust of air, water, the alimentary canal, under the nails, on and in the superficial layers of skin, especially in the axillæ and perineum. It forms the characteristic color only when it grows in air. It is killed in ten minutes by a moist temperature of 58° C., and is instantly killed by boiling water. Carbolic acid (1 : 40) and corrosive sublimate (1 : 2000) are quickly fatal to these cocci.

Staphylococcus pyogenes albus (Plate 1, Fig. 2), the white staphylococcus, acts like the aureus, but is more feeble in power. When this organism is found upon and in the skin it is called the staphylococcus epidermidis albus, an organism which Welch proved to be the usual cause of stitch-abscesses.

Staphylococcus pyogenes citreus, the lemon-yellow coccus, is found occasionally in acute circumscribed suppurations, but far more rarely than the other two forms. Its pyogenic power is even weaker than that of the albus.

Staphylococcus cereus albus, is found occasionally in acute abscesses.

Staphylococcus cereus flavus is found occasionally in acute abscesses.

Staphylococcus flavescens is occasionally found in abscesses. Is intermediate between the aureus and albus (Senn).

Micrococcus pyogenes tenuis rarely takes the form of a bunch of grapes. Is occasionally found in the pus of acute abscesses.

Streptococcus pyogenes (Fig. 12) is found in spreading suppuration. Woodhead tells us (Treves' *System of Surgery*) that six organisms, each of which bears a separate name, are discussed under this designation. Three of these organisms he places in one group, two in another, and says the sixth may be a separate species.

1st Group.—*Streptococcus pyogenes*, found especially in spreading suppuration and in very acute abscesses. Cheyne says that 16 per cent. of acute abscesses contain streptococci. Is easily killed by boiling, and can be destroyed by carbolic acid and corrosive sublimate. Exists normally in the nasal passages, vagina, mouth, and urethra.

Streptococcus pyogenes malignus, an uncommon organism found in splenic abscess.

Streptococcus septicus has a strong tendency to break up into diplococci.

1 2 3

1. Staphylococcus pyogenes aureus.
2. Staphylococcus pyogenes albus.
3. Bacillus tuberculosis on glycerin-agar.

(Warren's *Surgical Pathology*.)

2d Group.—*Streptococcus of erysipelas*, found in capillary lymph-spaces in erysipelas. Many bacteriologists believe it to be identical with the streptococcus pyogenes.

Streptococcus of Septicemia and Pyemia.—Most observers maintain that it is identical with the streptococcus pyogenes and streptococcus of erysipelas.

3d Group.—*Streptococcus articulorum*, found in false membrane of diphtheria (see the article by Woodhead in the *System of Surgery* by Frederick Treves).

The *micrococcus tetragenus* is thought to be the bacterium chiefly responsible for the suppuration of tubercular pulmonary lesions.

Bacillus pyogenes fœtidus, found especially in the pus of ischiorectal abscesses.

Bacillus pyocyaneus, found by Ernst in blue pus.

The gonococcus, the pneumococcus, the bacillus of typhoid fever, and the colon bacillus have pyogenic power.

Other Surgical Microbes.—*Streptococcus of erysipelas* (Fehleisen's coccus), as stated before, is thought by many to be identical with the streptococcus pyogenes. Their difference in action is believed by Sternberg to be due to difference in virulence induced by external conditions and by the state of the tissues of the host. The coccus of erysipelas is somewhat larger than the ordinary form of streptococcus pyogenes. Infection takes place by a wound, often a very trivial wound of the skin or mucous membrane. The organism multiplies in the small lymph-channels. This organism will cause puerperal fever in a woman in childbed when it gains access to "an absorbing surface in the genital tract" (Senn). The streptococcus may cause suppuration in erysipelas, mixed infection not being necessary to induce pus formation.

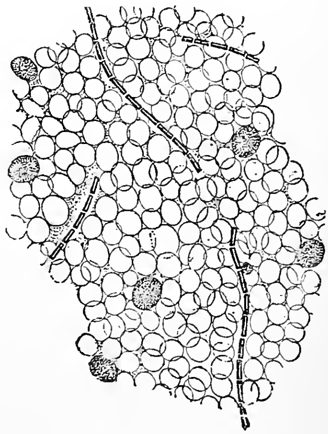


Fig. 13.—Anthrax bacilli in blood (Vierordt).

The *gonococcus* (Fig. 14, the bacillus of Neisser), the diplococcus which causes gonorrhea. Bumm proved the causative influence of the gonococcus. He reproduced the disease in a healthy female urethra by inoculation with

the twentieth generation in descent from a pure culture. Diplococci are found often in the secretions of apparently healthy mucous membranes, and simulate very closely gonococci. Gonococci cannot be cultivated upon ordinary media, but grow best upon human blood-serum. In gonorrhea the organisms are found both within and outside of pus-cells and

FIG. 14.—Gonococci from gonorrheal pus.

mucus-cells. It seems reasonably certain that the gonococcus is pyogenic, although it is possible that the pus formed in gonorrhea is due to mixed infection. Gonococci stain easily and are readily decolorized by Gram's method.

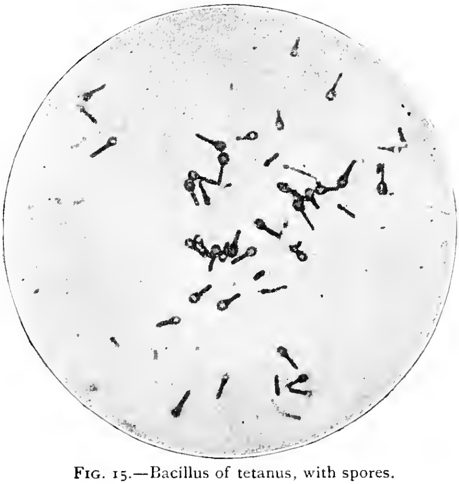


FIG. 15.—Bacillus of tetanus, with spores.

Streptococci are found in noma. No specific organism has been isolated for traumatic spreading gangrene or hospital gangrene.

The *bacillus tetanus* (Fig. 15, Nicolaier's bacillus), an anaërobic organism, found especially in the soil of gardens, in the dust of old buildings, in street dirt, and in the sweepings

of stables. Spores develop at the ends of these bacilli. The bacilli are capable of producing toxins of deadly power. The spores are very resistant and it is difficult to kill them. The drug which is most certainly fatal to tetanus bacilli is bromin.

The *bacillus tuberculosis* (Koch's bacillus, Plate 1, Fig. 3), the cause of all tubercular processes, is met with especially in dusty air which contains the dried sputum of victims of phthisis. This infected air is the chief means of transmission of the disease, though it may be conveyed by the milk of tubercular cows and the meat of tubercular animals. Wounds may open a gateway for infection. Fig. 16 shows tubercle bacilli in sputum.

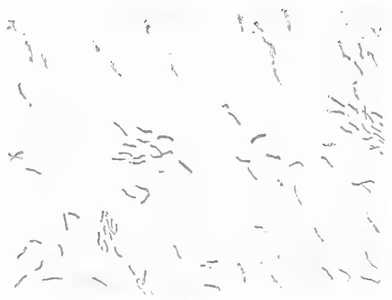


FIG. 16.—Tubercle bacilli in sputum (Ziegler).

Bacillus anthracis (Fig. 13), the cause of malignant pustule, or splenic fever.

Bacillus mallei, the cause of glanders.

Bacillus of syphilis (Lustgarten's bacillus). That syphilis is due to a micro-organism is highly probable, but that we have found the causative organism in Lustgarten's bacillus is by no means sure. A fact which points strongly against its causative power is that it is found rather in non-contagious tertiary lesions than in contagious secondary lesions.

Diplococcus pneumoniæ is believed to be the cause of pneumonia and acute meningitis. It is found normally in the human saliva. This organism is often spoken of as Fränkel's bacillus and also as the diplococcus lanceolatus.

The *bacillus coli communis*, called also the bacterium coli commune or the bacillus of Escherich (Fig. 17). Feces invariably contain this organism. It is believed by many observers to be the cause of appendicitis, peritonitis, abscesses about the intestine, many ischiorectal abscesses, some peri-

renal abscesses, certain cases of cystitis, cholangitis, and cholecystitis. In cases of appendicitis we can get a pure culture of Escherich's bacillus, but usually find also streptococci, staphylococci, or pneumococci. The colon bacillus has pyogenic power.

The *bacillus of malignant edema* (the vibrione septique of Pasteur), found especially in stagnant water and certain varieties of soil. In the disease known as malignant edema there is a mixed infection with the bacilli of malignant edema and saprophytic organisms, and the latter form considerable quantities of gas in the tissues. The bacilli of malignant edema may cause spreading gangrene.

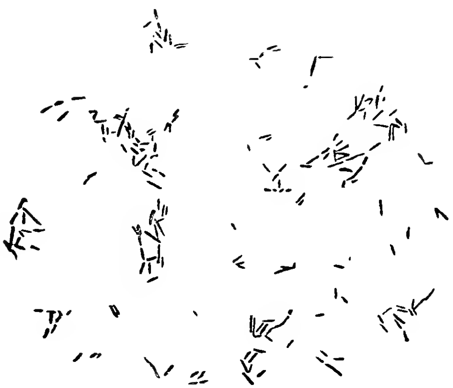


FIG. 17.—Bacillus coli communis.

The *bacillus of typhoid fever* (Eberth's bacillus) is responsible for some cases of gangrene, some of embolism, and not a few of bone and joint disease. It has pyogenic power.

We may mention, in conclusion, as of occasional surgical importance, the bacillus of influenza, bacillus of diphtheria, bacillus of bubonic plague, bacillus of leprosy, bacillus of rhinoscleroma, bacillus of fetid ozena, bacillus of hemorrhagic septicemia, bacillus lactis aërogenes (an occasional cause of peritonitis), and the bacillus aërogenes capsulatus. The later organism causes gangrenous cellulitis, a spreading gangrene accompanied by gas formation.

The putrefactive organisms are responsible for many septic intoxications.

II. ASEPSIS AND ANTISEPSIS.

The effort in all operations is to secure and maintain scrupulous surgical cleanliness. What is known as the antiseptic method we owe to the splendid labors of Lord Lister, and the aseptic method is but a natural evolution of the antiseptic method. Lister called the attention of the profession to a new method of treating wounds, compound fractures, and abscesses in 1867.[1] The processes first employed were extremely complicated, but have been made in the last few years simple and easy of performance. Lister believed the chief danger to be from air. It is now believed that the chief danger is from actual contact of hands, instruments, dressings, or foreign bodies with a wound. Air carries but few micro-organisms unless it is filled with dust. Infection through air is most apt to occur if the air is dusty, and is more common after an aseptic than an antiseptic operation.

Of course, some bacteria from the air must settle in every wound, but the majority of air fungi are harmless. Comparatively few reach the wound unless the air is dusty, and these few the tissues are usually able to destroy. Schimmelbusch made experiments in von Bergmann's clinic when the students were present. He found that "the number of bacteria which settle upon the surface of a wound a square decimeter in extent, in the course of half an hour, is about 60 or 70," and thousands are usually required to produce infection.

There is no danger of the breath alone producing infection. Air which comes from the lungs is germ-free, and even a large class will not infect the air by breathing, but will rather help free it from bacteria, for the lungs are filters for air laden with micro-organisms. Mikulicz believes that the surgeon in talking, coughing, etc., is apt to project infective particles into the wound, and so he advises the wearing of a respirator over the mouth.

Surgical cleanliness may be obtained by either the *aseptic* or the *antiseptic* method. In the aseptic method heat, chemical germicides, or both are used to cleanse the instruments, the field of operation, and the hands of the surgeon and his assistants, the surface being freed from the chemical germicide by washing with boiled water or with saline solution. After the incision has been made no chemical germicide is used, the wound being simply sponged with gauze sterilized by heat; if irrigation is necessary, boiled water or normal salt solution is used, and the wound is dressed with gauze which has been rendered sterile by heat. The effort

[1] *The Lancet.*

of the surgeon is simply to prevent the entrance of micro-organisms into the tissues. Some micro-organisms must enter, but the number will be so small that healthy tissues will destroy them. The aseptic method should be used only in non-infected areas. If chemical germicides are not used, the amount of wound-fluid will be small and the surgeon can often dispense with drainage. If a wound is to be closed without drainage, every point of bleeding must be ligated. It is often advisable to sew up the wound with Halsted's subcuticular stitch. If this stitch is employed, the skin staphylococcus does not obtain access to stitch-holes and stitch-abscesses are not apt to arise. This suture may consist of catgut, silk, or, preferably, silver wire, this latter agent being capable of certain sterilization by heat and exercising a powerful inhibitory action on micro-organisms. If a wound is closed without drainage, firm compression is applied over the wound to obliterate any cavity which may exist. In some regions of the body wounds are sealed with collodion or iodoform-collodion. If irrigation is not practised and the wound is dressed with dry sterile gauze, the procedure is said to be by the "dry" aseptic method. In the antiseptic method the same preparations are made for the operation as in the aseptic method, but during the operation sponges impregnated with a chemical germicide are used, and the wound is dressed with gauze containing corrosive sublimate or some other chemical germicide. If the wound is not flushed with a chemical germicide, and is dressed with dry antiseptic gauze, the operation is said to be by the "dry" antiseptic method. The antiseptic method is preferred in infected areas. Dry dressings are usually preferable to moist dressings, because they are more absorbent and do not act as poultices, and dry dressings may be used even when the wound has been flushed. In suppurating areas it is often best to use moist dressings in the form of antiseptic fomentations. Year by year the aseptic method becomes more popular. Surgeons have learned that the most important factor in asepsis is mechanical cleansing by means of soap and water. The chemical germicide plays a secondary rather than a vital part. By mechanical cleansing great numbers of micro-organisms are removed along with dirt, grease, and epithelium. Many organisms remain, but vast hordes are washed away, and the danger of infection is greatly lessened by thus diminishing the number of organisms. If a chemical germicide is used without preliminary mechanical cleansing, it is useless, because it cannot destroy

bacteria in the epithelium and in masses of oily matter. After the use of mechanical cleansing the germicide is active in destroying the comparatively few bacteria which are naked on the surface. In many regions a strong chemical germicide must not be used (in the abdomen, in the brain, in joints, in the pleural sac, and in the bladder), and in other regions (mucous surfaces and fatty tissue) it is productive of harm rather than good.

Preparations for an Operation.—A room in which an operation is to be performed should be well lighted and well ventilated. It is advantageous to have an open grate in the room, for then a fire can be quickly made to take a chill off the air and ventilation is improved. The morning before the operation furniture should be removed, the carpet taken up, and curtains and hangings taken down. If the ceiling and walls are papered, they must be thoroughly brushed. If they are painted, they must be washed off with soap and water. Dust is thus removed, and the danger of dust falling into the wound is averted. The floor is scrubbed with soap and water. The windows should be opened for many hours to thoroughly dry and freshen the room. On the morning of the operation the patient's bed is brought into the room and placed in a position where there will be plenty of light for future dressings, and where the surgeon will have access from either side. Never use a big broad bed; use a narrow bed. Never have a feather bed, but insist on Treves's advice being followed, and employ a metal bed with a wire netting and hair mattress.

A piece of carpet or rug is spread upon a portion of the floor and the table is set upon it. The table should be so placed that there will be a good light on the field of operation. A kitchen table does very well. On the table is placed a folded comfortable or several folded blankets.

Around the operating-table at proper distances are arranged a table for instruments, a table for dressings, a table for sponges and a basin of bichlorid, and a table for soap and a basin of water. A couple of buckets should be placed on the floor near at hand. The nurse and assistants should have ready the ether cone, wrapped in a clean towel, sterile sheets, sterile gowns, sterile towels, sterile gauze for sponges and dressings, trays for instruments, iodoform gauze, catgut, silk, silkworm-gut, etc., according to the nature of the operation. The surgeon should pick out the instruments required. The anesthetizer should lay out a mouth-gag, tongue-forceps, a hypodermatic syringe

in working order, ether or chloroform, brandy, tablets of strychnin, and also of atropin.

The patient has been prepared the day before, except in emergency cases.

The surgeon and his assistants remove their coats, roll up their sleeves, and, after sterilizing the hands and forearms, envelop their bodies in aseptic or antiseptic sheets or gowns, to protect the patient and themselves. It is a good plan for the surgeon and his assistants to wear sterile muslin caps. The caps prevent hair, dandruff, and sweat falling into the wound.

It is a difficult or impossible matter to absolutely sterilize the hands, but it is fortunate, as Mikulicz and Flugge say, that most of the bacteria of the skin are harmless. The staphylococcus epidermidis albus, however, is constantly present in the epidermis. The hands of some persons are more easily sterilized than those of others. For instance, a hairy, creased hand is more difficult of sterilization than a smooth and almost hairless one; a hand grossly neglected than one reasonably clean. Germs abound in the epidermis, in the fissures and creases, under and around the nails, on hairs, and in the ducts of glands. The surface of the hands may be thoroughly sterile at the beginning of an operation and become infected later, because germs in gland ducts are forced to the surface. Hence, in a prolonged operation, the surgeon should stop from time to time and wash his hands, first in alcohol and then in corrosive sublimate solution (Leonard Freeman).

In view of the difficulty of cleansing the hands, every student must be taught how to do it. The more hands used in an operation the greater is the danger of infection of the wound. The surgeon's fingers must enter the wound. The fingers of no other person should enter unless absolutely necessary.

The hands and forearms are sterilized in the following manner: Scrub for five minutes with soap and hot sterile water, giving special attention to the nails and creases in the skin. The brush is rubbed in the long axis of the extremity and also transversely. The creases on the back of the hands and fingers will be partially opened by flexing the fingers, and transverse scrubbing will clean the furrows. The furrows on the palmar surface will be opened by extending the fingers, and will be best cleaned by transverse scrubbing (G. Ben. Johnson). The best soap is the ethereal soap of Johnston, which is a solution of castile soap in ether. Green, or castile, soap can be used. The brush employed should be kept in a 1 : 1000 solution of corrosive sublimate.

The nails are cut short, are cleansed with a knife, and the hands are again scrubbed. After washing off the soap the hands are dipped for a moment in pure alcohol, and the forearms are rubbed with alcohol. Alcohol removes the soap which has entered into follicles and creases, removes desquamated epithelium, enters under and about the nails, and favors the diffusion of the corrosive sublimate under the nails and into the follicles, when the hands are placed later in the mercurial solution. After using the alcohol the hands are then dipped in a hot solution of corrosive sublimate (1 : 1000), and with the forearms are scrubbed for at least a minute, the nails receiving especial care. Kelly disinfects the hands by washing them with soap and water, dipping them in a solution of permanganate of potassium (a saturated solution in distilled water), and decolorizing them in a saturated solution of oxalic acid and washing off the oxalic acid in sterile water.

Weir has highly commended the following plan, and Stimson is also pleased with it: Scrub the hands with a brush and green soap and in running hot water. Clean under the nails with a piece of soft wood. Place about a tablespoonful of chlorinated lime in the palm of the hand, place upon the lime an equal amount of crystalline washing-soda, add a little water, and rub the creamy mixture over the arms and hands until the rough granules of sodium carbonate are no longer felt. Place the paste under and around the nails by means of a bit of sterile orange wood. Wash the arms and hands in hot sterile water.[1] The combination forms nascent chlorine, a most efficient germicide. This method has proved most satisfactory in the clinic of the Jefferson Medical College Hospital. It is important that crystalline washing-soda be employed. If the bicarbonate is used, nascent chlorine will not be produced, but hydrochloric acid gas will be formed, and the latter gas irritates the skin and is not a satisfactory germicide.

Some surgeons are so impressed with the impossibility of sterilizing the hands that they wear gloves in operations. Hunter Robb suggested the use of gloves in 1894. Mikulicz used white cotton gloves. Lockett has proved that cotton and silk are not impervious to micro-organisms, but that rubber is. The thin, seamless rubber gloves which are now made are very satisfactory. They are sterilized by boiling, are then dried, and are wrapped in a sterile towel. In order to insert the hand in them, the interior of the glove

[1] *Medical Record*, April 3, 1897.

should be first dusted with sterile starch or talc powder, and then the nurse should hold the glove while the surgeon inserts his fingers into the proper compartments and pushes the hand in.

If, during an operation, a glove becomes infected, a clean one can be substituted for it. Gloves somewhat impair the sense of touch, but a surgeon soon learns to work with them. If they are to be used, the hands should be sterilized just as carefully as when they are not to be used, because, during the operation, the gloves may tear or be punctured by a needle. That it is absolutely necessary to wear gloves in all cases has not been proved. Their use does contribute to success in brain operations, abdominal operations, and joint-operations. They are of great value in military surgery.

When a surgeon is obliged to place his fingers in an area of virulent infection he may be poisoned. Gloves will save him from this danger. Again, a surgeon should try to avoid bringing his hands unnecessarily in contact with putrid or purulent matter. Though it may not poison him, it grossly infects the surface, renders subsequent cleansing difficult, and endangers other patients. Gloves will prevent this danger. A surgeon should wear gloves if he is making an examination or performing an operation which is sure to infect grossly the bare hands, and he should wear gloves in an operation if in a previous operation his hands were grossly infected.

Instruments are disinfected by boiling for fifteen minutes in a 1 per cent. solution of carbonate of sodium and then rinsing them in a 5 per cent. solution of carbolic acid or in sterile water. The carbonate of sodium prevents rusting. In a clinic the boiling is carried out in a Schimmelbusch

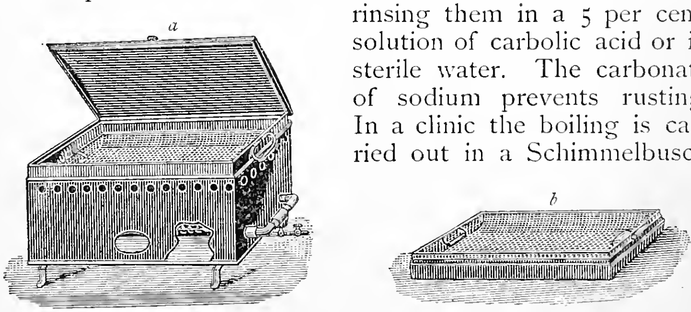


Fig. 18.—Schimmelbusch's gas-heated apparatus for sterilizing instruments: *b*, wire basket.

sterilizer (Fig. 18). In a private house it can be done in a sterilizer such as that shown in Fig. 19, or in a pan

or a wash-boiler. A sterilizer with a tray is better than an ordinary pan or kettle, because, when the latter is used, the metal instruments lie in the bottom of the vessel, where the heat is very great and the temper may be impaired. Boiling unfortunately destroys to some extent the keenness of cutting instruments, the ebullition throwing them about. Hence the knives should be wrapped in cotton to preserve the edges. After sterilization the instruments are placed in trays containing boiled water. After the completion of the operation the instruments should be scrubbed with soap and water, boiled in soda solution, and dried. Instruments can be partially disinfected by keeping

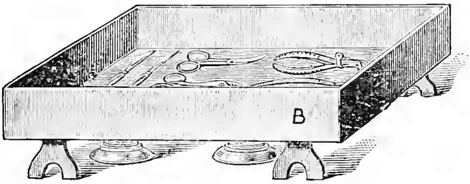


FIG. 19.—Portable sterilizer.

them for fifteen minutes in a 5 per cent. solution of carbolic acid. Instruments with handles of wood must not be boiled. If such instruments are used, they can be disinfected by the use of carbolic acid, but they should not be used. Metal instruments, whenever possible, should consist of one smooth piece. Grooves and letters are objectionable as dirt gathers in such depressions. Ivory handles cannot be boiled.

Whenever possible, give the patient some days' rest in bed before a severe operation, and place him on a diet nutritious but not bulky. The night before the operation give a saline cathartic, and the morning of the operation employ an enema. Emptying the bowels lessens the danger of sepsis after operation. It is desirable that the rectum be empty, because in shock the absorbing power of the stomach is greatly diminished or is even abolished for the time, and we may wish to utilize the absorbing power of the rectum and give stimulants by enema. When a patient is under ether, or when he is profoundly shocked, of course no attempt is made to give stimulants by the mouth. Whenever possible, give a general warm bath the day before the operation. The evening before the operation scrub the entire field of operation, and well clear of it, with soap and water; shave if necessary; wash with ether; scrub well

with hot corrosive-sublimate solution (1 : 1000); apply a layer of moist corrosive-sublimate gauze, and place over this dry antiseptic gauze, a rubber dam, and a bandage. Many surgeons apply a poultice of green soap for many hours in order to separate masses of epithelium and with them many germs. On removing the dressings to perform the operation cleanse the part exactly as before. In emergency cases disinfection can only be practised just previous to the operation. Disinfection can be thoroughly effected by the use of chlorinated lime (Weir, Stimson). Surround the field of operation with dry sterile sheets.

To clean the vagina or rectum, use a sponge soaked with creolin and Johnston's ethereal soap (1 : 16), and subsequently irrigate with hot saline fluid or boric acid solution.

If an operation is to be performed **within the mouth**, old snags and carious teeth should be removed. To cleanse the mouth scrub the teeth with a brush and castile soap twice a day and rinse the mouth, nares, and pharynx with peroxid of hydrogen, or a solution of boracic acid, every three hours for several days.

Irrigation is often practised in septic wounds, but is not required in aseptic wounds. Among irrigating fluids we may mention corrosive sublimate, carbolic acid, peroxid of hydrogen, boric acid solution, and normal salt solution. Hot normal salt solution is the best agent with which to irrigate the peritoneal cavity, the pleural sac, the interior of joints, and the surface of the brain. This solution contains 0.6 per cent. of sodium chlorid.

Many surgeons employ Landerer's dry method in operating aseptically. No fluid is applied to the wound. As the wound is enlarged gauze sponges are packed in to arrest hemorrhage. On the completion of the operation the sponges are removed, any bleeding points are ligated, and the wound is closed without drainage.

The favorite **ligature-material** is catgut. Catgut undergoes absorption in the tissues. Years ago attempts were made by Scarpa, Crampton, and Physick to use absorbable sutures. Sir Astley Cooper tried catgut. These attempts failed because the material employed was septic, suppuration ensued, the wound gaped, and the ligature was cast off prematurely. Surgeons remained content with non-absorbable ligatures of silk or linen. These ligatures were not cut short, but a long end was left to each one, and the ends were allowed to hang out of the wound. These ligatures were lightly pulled upon from time to time, and when

they loosened or cut through were removed. Catgut is the submucous coat of the intestine of the sheep, and is the material from which violin-strings are made. It was reintroduced into surgery by Lister. It is obtained in the following manner: The small intestine, after separation from the mesentery, is washed in water, laid upon a board, and scraped with a metal instrument. Thus the mucous coat and the muscular coat are scraped away, and the submucous coat only remains. The submucous coat is cut into strips, and each strip is twisted into a coil. Raw catgut is an infected material. It is hard to sterilize because in the twisting many organisms get into the interior of the strand, where it is difficult for antiseptics to reach them. Raw catgut obtained from animals dead of splenic fever contains spores of anthrax. If not thoroughly disinfected, catgut is dangerous, and some surgeons consider its cleanliness always a matter of grave question and will not use it. Surgeons' catgut can be bought from the dealer in skeins containing thirty yards. It should be rough and yellow. The smooth white variety should not be gotten. It has been rubbed smooth with a piece of glass and bleached with a chemical, and in consequence is weak and unreliable. The smallest size is known as double zero, then come single zero, No. 1, No. 2, No. 3, and No. 4. The usual ligature size is No. 2. Nos. 3 and 4 are only used for tying thick pedicles. Nos. 1 and 2 are used for suturing the dura and peritoneum, and for tying small vessels in the brain. McBurney and Collins state that when catgut is used to tie delicate tissue (omental masses, intestinal surfaces, etc.), it must first be softened by immersing for half a minute in normal salt solution. If this precaution is neglected and wiry catgut is used, the ligature or suture will cut and hemorrhage will occur.[1]

If catgut is thoroughly prepared, and the wound in which it is used is aseptic, it is a most satisfactory ligature material, is absorbed in the wound after being cut off short, and produces no trouble although it does increase slightly wound secretion. The smaller sizes are absorbed in four or five days, No. 2 lasts from nine to ten days, Nos. 3 and 4 from ten days to three weeks.

One of the following methods of preparation may be used: The catgut is soaked in ether for twenty-four hours to remove fat. It is then wound on glass spools, transferred to alcohol, and boiled under pressure. The boiling is conducted in a heavy metal jar with a well-fitting

[1] *International Text-Book of Surgery.*

screw-top. The jar is half filled with alcohol. The spools of catgut are placed in the jar, the lid is screwed down, and the apparatus is immersed in boiling water for half an hour. The gut is kept in this jar until needed. Fowler's catgut is prepared by boiling in alcohol. It is placed in hermetically sealed V-shaped glass tubes. Each tube contains alcohol and twelve ligatures. The alcohol is boiled *by immersing the tube in* boiling water. The cumol method is employed by Kelly in the Johns Hopkins Hospital, and is known as Krönig's method. Cumol is a fluid hydrocarbon which boils at 179° C. Catgut is wound upon spools of glass, and these are placed in a beaker-glass, the bottom of which is covered with cotton. A bit of cardboard is placed on top of the beaker, and through a small perforation in the cardboard a thermometer is introduced. The beaker is placed in a sand-bath and the bath is heated by means of a Bunsen burner. The temperature is gradually raised to 80° C., and is kept at this point for one hour, in order entirely to remove moisture from the gut. Cumol, at a temperature of 100° C., is poured into the glass, and the heat is increased until the temperature of the cumol is about 5 degrees below its boiling-point (165° C.). For one hour this temperature is maintained. Then the cumol is poured off and the catgut is allowed to remain for a time in the sand-bath at a temperature of 100° C., in order to dry. It is transferred for keeping into sterile glass jars or test-tubes.[1]

The formalin method is advocated by the elder Senn. The catgut is wound on glass test-tubes, and is immersed in an aqueous solution of formalin (2–4 per cent.) for twenty-four to forty-eight hours. It is placed in running water for twelve hours to get rid of the formalin. It is boiled in water for fifteen minutes, is cut in pieces and tied in bundles, placed in a glass-stoppered jar, and is kept ready for use in the following mixture: 950 parts of absolute alcohol, 50 parts of glycerin, and 100 parts of pulverized iodoform. Every few days the mixture should be shaken.

Senn's process is a modification of Hoffmeister's. Even sterile catgut contains a toxic substance which increases wound secretion, has a poisonous effect on body cells, and favors to some extent limited suppuration. Senn maintains that in order to counteract this influence gut should not only be sterile, but should be antiseptic to inhibit the growth

[1] See McBurney and Collins, in *International Text-Book of Surgery*, and Clark, in *Johns Hopkins Hospital Bulletin*, March, 1896.

of pyogenic organisms which reach the wound during operation or by the blood.

Bœckman wraps catgut in paraffin-paper, seals it in a paper envelope, puts it in the sterilizer, and subjects it to dry heat. For three hours it is heated to a temperature of 284° F., and for four hours to a temperature of 290° F. The envelope can be carried in the pocket or the instrument-bag. When the gut is wanted the end of the envelope is torn off, an assistant with sterilized hands unwraps the paraffin-paper, and the gut is dipped for a moment in sterile water to make it pliable.[1]

A method which has been largely used is to take raw catgut, keep it in ether for twenty-four hours, soak it for twenty-four hours in an alcoholic solution of corrosive sublimate (1 : 500), wind it on sterilized glass rods, and place it for keeping in ether or in alcohol. Johnston's quick method of preparing catgut is as follows: place it for twenty-four hours in ether; at the end of this period place it in a solution containing 20 grains of corrosive sublimate, 100 grains of tartaric acid, and 6 ounces of alcohol. The small gut is kept in this for ten or fifteen minutes, the larger gut from twenty to thirty minutes, but never longer. It is placed for keeping in a mixture containing 1 drop of chlorid of palladium to 8 ounces of alcohol. This gut is strong and reliable. At the time of operation the gut is placed in a solution one-third of which is 5 per cent. carbolic-acid solution and two-thirds of which are alcohol. Chromicized catgut is absorbed less rapidly than ordinary catgut. It is used to tie thick pedicles and large arteries, to suture nerves and tendons, and as a suture-material in the radical cure of hernia. Chromicized gut, No. 3 and No. 4, will remain unabsorbed in the tissues from four to six weeks. The gut should be soaked in ether for twenty-four hours, and placed for twenty-four hours in a 4 per cent. solution of chromic acid in water. The gut is then dried in a hot-air sterilizer and disinfected by one of several methods. The cumol method is satisfactory.

Kangaroo-tendon will be absorbed in the tissues, but only after a long time (sixty to seventy days). This material is especially useful as a buried suture in hernia-operations. It can be prepared in the same manner as the chromicized catgut, and it ought always to be chromicized. Marcy's plan is as follows: Soak the dried tendon in a solution of corrosive sublimate (1 : 1000) and separate the individual strands. Dry

[1] James E. Moore, in *Philada. Med. Journal*, June 22, 1898.

each strand in an antiseptic towel. Chromicize the gut and keep until needed in boiled linseed oil containing 5 per cent. of carbolic acid. Before using the strands take them out of the oil, wipe off the oil with a sterile towel, and immerse the tendon for half an hour in a 1 : 1000 solution of bichlorid of mercury. *Silk* can be used for both ligatures and sutures; many sizes should be kept on hand. White silk may be used, or black silk, which is more easily visible. Silk is not absorbed but is encapsuled. It is not a good material for buried sutures, as in the long run it may form a sinus. Sutures of silk should be boiled for half an hour before using in a 1 per cent. solution of carbonate of sodium. A convenient method of preparation is to wind the silk on a glass spool, place the spool in a large test-tube, close the mouth of the tube with jewellers' cotton, introduce the tube into a steam sterilizer, and subject it to a pressure of ten pounds for twenty minutes, repeating the process the next day. These tubes are carried in wooden boxes sealed with rubber corks. *Silk-worm-gut* contains fewer bacteria than catgut and does not swell when introduced into a wound. It is a very valuable suture-material, but is not used for ligatures. Silkworm-gut is prepared by placing it in ether for forty-eight hours and in a solution of corrosive sublimate (1 : 1000) for one hour, or it can be boiled in plain water for half an hour. It is carried in a long tube filled with alcohol. A few minutes before using the gut is placed in carbolic acid and alcohol (one-third of the solution is a 5 per cent. solution of acid, two-thirds of it are alcohol). Silk and catgut should be tied by the reef-knot. Silkworm-gut is tied by the surgeon's knot. In tying catgut the first knot is tied tightly, and the second knot firmly but not tightly. If the second knot is tied tightly, it is apt to cut the ligature (Greig Smith). *Silver wire* is prepared by boiling. It is a very useful suture-material, as it can be thoroughly sterilized and has an inhibitory effect on the growth of bacteria. Some surgeons use it for buried sutures, but many are opposed to using it thus on the ground that it is apt to lead to sinus-formation.

Most wounds are closed by interrupted sutures of silk-worm-gut, but silk, catgut, chromic catgut, or silver wire can be used. The old continuous suture (glovers' stitch) is rarely used. An admirable closure can be effected by Halsted's subcuticular stitch, and scarcely any scar results. Marcy's buried tendon sutures are very valuable, especially in hernia-operations and in various operations upon the abdomen.

Dressings are made of cheese-cloth. In order to make antiseptic gauze the cheese-cloth is boiled in a solution of carbonate of sodium, rinsed out, and dried; it is then soaked for twenty-four hours in a solution containing 1 part of corrosive sublimate, 2 parts of table-salt, and 500 parts of water. It is placed in clean jars with glass lids, and it may be kept moist or dry.

Sterilized or aseptic gauze is prepared by boiling in carbonate of sodium, etc., as described under Antiseptic Gauze. It is wrapped in a towel and is placed in a steam-sterilizer for an hour (Fig. 20). It is kept in sterile glass jars with glass lids. The pads for sponging are made by rolling up portions of sterile gauze. Ashton's abdominal pads are

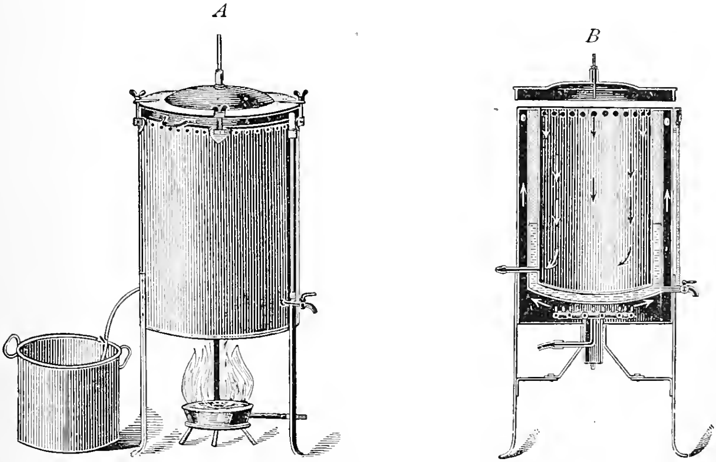


FIG. 20.—Lautenschläger's steam-sterilizer for dressings: *A*, exterior view; *B*, cross-section.

made by taking several layers of sterile gauze, each piece about six inches long and four inches wide, running a stitch around the margin, and sewing a piece of tape into one corner.

Sterile absorbent cotton is prepared in the same manner as gauze. Cotton is useful as a dressing to supplement gauze, being placed on the outside of the gauze. It absorbs quantities of serum, but will take up very little pus.

Iodoform gauze is very useful for packing in the brain and abdomen, for packing abscesses and tubercular areas, and for dressing foul wounds. It is prepared as follows: Make an emulsion composed of equal parts by weight of iodoform,

glycerin, and alcohol, and add corrosive sublimate in the proportion of 1 part to the 1000 of the mixture. This mixture stands for three days. Take moist bichlorid gauze, saturate it with the emulsion, let it drip for a time, and keep it in sterilized and covered glass jars (Johnston). Lister's cyanid gauze (double cyanid of zinc and mercury) is not certainly antiseptic, and must be dipped into a corrosive-sublimate solution (1 : 2000) before using. All forms of gauze can be bought ready prepared from reliable firms. Some surgeons place silver foil upon a wound before applying the gauze (Halsted, p. 30). Small wounds in which drainage is not employed may often be dressed by laying a film of aseptic absorbent cotton over the wound and applying, by means of a clean camel's-hair brush, iodoform collodion (grs. xlviij of iodoform to ʒj of collodion).

When a wound is dressed with gauze a rubber-dam is sometimes laid over the dressings, so as to diffuse the dis-

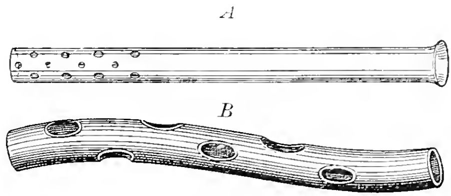


FIG. 21.—Drainage-tubes: *A*, glass; *B*, rubber.

charge and prevent it from coming rapidly to the surface. The use of the rubber-dam is not nearly so common as formerly. In an aseptic wound dry dressing uncovered by rubber is the most useful. When a dressing is covered by an impermeable material it becomes wet, acts as a poultice, and the discharges on the dressing may undergo decomposition. A rubber-dam before being used should be washed with soap and water and soaked in a solution of corrosive sublimate. Drainage is obtained when needed by rubber or glass tubes, by strands of horsehair, silkworm-gut, or catgut, or by pieces of gauze. Rubber drainage-tubes (Fig. 21, *B*) are prepared by boiling in plain water. They are kept until wanted in a mercurial solution. This solution should be changed every few days, because the mercury is apt to be precipitated as sulphid. Glass tubes are prepared by boiling. A bit of rubber tissue is sometimes used for drainage. This material is also used to cover surfaces which have been skin-grafted.

Rubber tissue, before being placed on or in a wound, must be washed with soap and water, rinsed in sterile water, and soaked in a solution of corrosive sublimate. Gauze, catgut, etc., are known as capillary drains. When moist they drain serum excellently, but pus very badly or not at all. Drainage-tubes or strands are brought out at a portion of the wound which will be dependent when the patient is recumbent. Drainage is used in all infected wounds, in most very large wounds, in wounds to which irritant antiseptics have been applied, and in cases in which large abnormal cavities exist. Dressings must be changed as soon as soaking is apparent, or if constitutional symptoms of wound infection arise, and the change must be effected with all of the aseptic care employed in the operation. Stitches may usually come out from the sixth to the eighth day, although if there is much tension on the edges of the wound they are allowed to remain several days longer. In large wounds, half of the stitches are taken out at one time, the remainder being allowed to remain for a couple of days longer. When a stitch begins to cut it is doing no good, and it should be removed no matter how short a time it has been in place. If it is allowed to remain, it will cut into the wound, make a stitch-abscess, and cause an irregular suture-line.

Preparation of Marine Sponges.—Marine sponges are rarely used. Gauze pads are preferred. Marine sponges absorb admirably, but they are hard to clean when new and cannot be certainly sterilized in their interiors after becoming badly infected. They may be prepared as follows: Beat out the dust; place them for forty-eight hours in a solution of hydrochloric acid (15 per cent.); wash them with water; place them for one hour in a solution of permanganate of potassium (ʒiij to 5 pints of water); soak for four hours in a solution containing 10 ounces of hyposulphite of sodium, 5 ounces of hydrochloric acid, and 3 pints of water; wash with running water for six hours. Keep the sponges in a jar containing corrosive-sublimate solution (1 : 1000). After using, wash in hot water, soak for half an hour in a solution of sodium carbonate (1 : 32), wash in hot water, and replace in corrosive sublimate.

Senn's Decalcified Bone-chips.—Take the shaft of the tibia or femur of a recently killed ox, saw it into portions two inches in length, remove the marrow and periosteum, and place the fragments of bone in a 15 per cent. solution of hydrochloric acid. Change the solution every twenty-four hours. In from two to four weeks the bone will be

decalcified. Wash in distilled water, place the pieces of decalcified bone for a few minutes in a dilute solution of potash to neutralize the acid, and then immerse for twenty-four hours in distilled water. The portions of bone are cut into strips in the direction of the long axis of the segments. Each strip is three-quarters of an inch wide and should be sliced into bits one millimeter thick. These chips are kept in an alcoholic solution of corrosive sublimate (1 : 500).

III. INFLAMMATION.

Definition.—When the tissues are injured they react or respond, and this reaction or response is known as inflammation. The process of inflammation is defined by Professor Burdon-Sanderson as "the succession of changes which occur in a living tissue when it is injured, provided that the injury is not of such a degree as at once to destroy its structure and vitality." Professor Adami, in his article upon inflammation in Allbutt's *System of Medicine*, points out that this definition really includes too much. He alludes to the hemorrhage which occurs in the liver after a traumatism, and the subsequent changes in the extravasated corpuscles, and points out that these changes are not inflammatory phenomena. This definition, however, includes all inflammatory conditions, is largely employed, is very useful, indicates the cause, and, as Burdon-Sanderson says, makes clear that inflammation is a process and not a state (Adami.) Adami's definition is as follows: "The series of changes constituting the local manifestation of the attempt at repair of actual or referred injury to a part, or, briefly, the local attempt at repair of actual or referred injury." The changes alluded to in Burdon-Sanderson's definition comprise—(1) changes in the vessels and the circulation; (2) departure of fluids and solids from the vessels; and (3) changes in the perivascular tissues.

Vascular and circulatory changes were formerly thought to be absolutely essential to inflammation in both vascular and non-vascular tissues. In the former they occur in the inflamed tissues; in the latter (cornea and cartilage) they are manifest in neighboring tissues from which the non-vascular area derives its nutritive material. As a matter of fact, in inflammation, vascular changes are almost always present; but in a rather trivial corneal inflammation the episcleral vessels may not dilate, and the only white corpuscles which gather in the damaged area are those which come

from the lymph-spaces of the cornea. Inflammation in any tissue will not be accompanied by vascular dilatation unless the process reaches a certain stage of severity.

Active Hyperemia.—When an irritant is applied to tissue there may be a momentary arterial contraction due to irritation of the nerves, but this contraction is transitory, and is not an inflammatory phenomenon. The first vascular phenomenon is dilatation of all the vessels—capillaries, venules, and arterioles—appearing first and being most pronounced in the small arteries. As a result of the dilatation there are increased rapidity of circulation and increased determination of blood to the part, and the area of hyperemia becomes warmer than is normal. This condition of increased circulatory activity is known as "active hyperemia" (Fig. 23).

Active hyperemia is an increase in the amount of moving blood in a part. Passive hyperemia is an increase in the amount of blood in a part, but not of moving blood, as passive hyperemia or congestion is due to venous obstruction, and the blood is stagnated. Plethora means an increase in the total amount of body blood. Diminution in the amount of blood in a part is ischemia. Anemia is a diminution in the amount of blood in the whole body because of hemorrhage or because of insufficient formation of blood. Local anemia is the complete cutting of the blood-supply of a part.

FIG. 22.—Normal vessels and blood-stream.

In active hyperemia more blood goes to the part and more blood passes through it, an increased amount of venous blood comes from the hyperemic area, the venous tension is increased, and the veins may even pulsate. The capillaries, which under ordinary circumstances contain but few blood-cells (Fig. 22), become filled with corpuscles (Fig. 23), and even the smallest capillaries pulsate. The blood in the veins adjacent to the area of inflammation is of

a much lighter red than in health. Many capillaries which were invisible under normal conditions become visible when active hyperemia exists. The capillaries contain no muscle-fiber, and hence these tubes cannot actively contract, except so far as the caliber of the tubes is altered by the contraction or expansion of the endothelial cells of the capillary wall. Contraction and dilatation of the capillaries depend chiefly upon the amount of blood sent to or retained in them. In active hyperemia the increased amount of blood sent to the part causes capillary dilatation. As a result of the dilatation the endothelial cells become thinner than before, the cells as a result of irritation lose some of their power to restrain exudation, and some observers assert that openings are formed between the cells or that previously existing openings enlarge. Fluid elements rarely leave the blood-vessels during active hyperemia, but they occasionally do. The wheals of urticaria are thus formed (Warren). Active hyperemia is often the first stage of an inflammation, but it is not of necessity followed by other inflammatory changes, and it can be caused by nerve-section or nerve-stimulation.

The duration of active hyperemia is variable. If the irritation was brief, the hyperemia is very transitory. If the irritation is prolonged, it may last some time before giving way to retardation. In the web of a frog's foot, if an irritant is applied, hyperemia lasts from one-half hour to two hours before it is replaced by retardation.

A hyperemic part, if in or near the surface, is red in color, imparts a sense of heat to the examining hand, the color quickly disappears on pressure and quickly returns when pressure is released. In a congested part the temperature is diminished, the surface is purple, the color slowly disappears on pressure and slowly returns when pressure is removed; there are edema and a sensation of coldness and numbness.

Retardation.—After active hyperemia has existed for a variable time the blood-current begins to lessen in velocity, until it becomes more tardy than in health. This is known as "retardation of the circulation." Retardation is first noted in the venules, next in the capillaries, and last in the arterioles; but arterial pulsation continues. The red cells take the center of the blood-stream, which is known as the axial current. The white corpuscles drop out of the central stream, separate from the red, and float lazily along near the vessel-wall. The white cells show a strong tendency to

adhere to the venule-walls, and, as a result, accumulate against the inside of, and stick to, these walls and to one another, until the veins are entirely lined with layers of *leukocytes* (Fig. 23). In the capillaries some leukocytes gather, but not many. In the arteries they adhere during cardiac dilatation, but are swept away by the force of the heart's contractions. Retardation is believed to be chiefly due to paresis of the muscular walls of the arterioles. This causation seems probable when we recall Lord Lister's experiments upon the pigment-cells of the frog's foot. Lister proved that inflammation paralyzes the pigment-cells, and concluded that dilatation at the focus of an inflammation is due to the paralyzing action of an irritant. Dilatation at a distance from the focus is a reflex phenomenon (W. Watson Cheyne). When the vessels are weakened or paralyzed the contractions of the arterioles are feeble or absent, and the blood is no longer urged forward by arterial power. The endothelial cells of the vessels enlarge and develop a condition of stickiness, which leads the white cells to adhere to them, and thus increases resistance to the current of blood and adds to retardation. Fluids pass through a vessel in this condition more readily than a healthy vessel, and white corpuscles leave the vessel in large numbers.

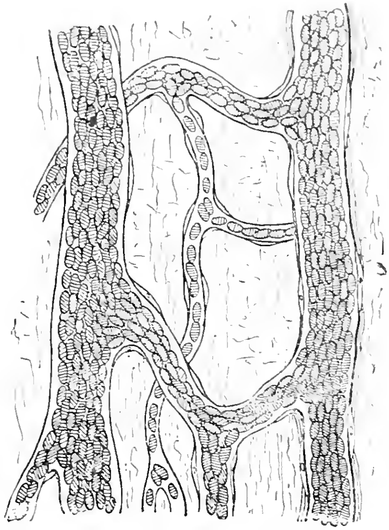


Fig. 23.—Dilatation of the vessels in inflammation.

Oscillation and Stagnation.—By this accumulation of leukocytes the blood-stream is progressively narrowed and the axial current is impeded. The red blood-cells begin to stick to one another, forming aggregations like *rouleaux* of coin, which masses increase the difficulty the axial current has to contend with, until progressive movement ceases and the contents of the vessels sway to and fro with the heart-beat. This is the stage of *oscillation*. In a short time oscil-

lation ceases and the vessels are filled with blood which does not move, and the vessel-walls become irregular in outline or even pouched. This stage is known as "stasis" or "stagnation" (Fig. 24). If stasis persists, coagulation occurs, because the vessel-walls have been so injured by the irritant as to be practically dead material, and they are no longer able to prevent clotting of their contents. Stasis is chiefly due to paralysis and damage of the vessel-walls. Diapedesis ceases when stasis takes place. We can then sum up the vascular changes of inflammation by stating that they consist in a dilatation of the small vessels and a primary acceleration, a secondary retardation, and a subsequent stagnation of the blood-current with adhesion of leukocytes to the walls of veins and capillaries, migration of leukocytes, and the aggregation into masses of the red blood-cells. If stasis persists, the vessel-walls become profoundly involved in the inflammatory change, and they may rupture or be completely destroyed.

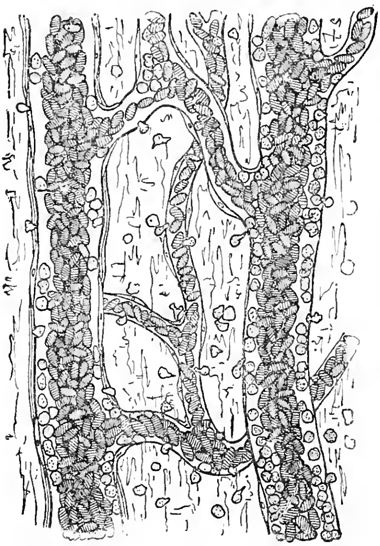


FIG. 24.—Stasis of blood and diapedesis of white corpuscles in inflammation.

Exudation of Fluids.—It is to be remembered that in the process of nutrition serum and even white cells pass into the tissues through the walls of veins and capillaries. Whenever inflammatory retardation of the circulation arises, there is an increase in the amount of plasma which passes out of the vessels, but in inflammation the exudation is vastly greater in amount and is different in composition. In a slight inflammation, and in the early stage of any inflammation, there is an increase in the fluid exudate, and we speak of the condition as "serous inflammation." This fluid is really not serum, but is liquor sanguinis. We find true serum in passive congestion, not in active inflammation. The fluid in a serous exudation contains very few white cells, and hence little or no fibrin can form in it, and coagu-

lation does not take place in the perivascular tissues; and if the inflammation goes no further, the exudate is absorbed by the lymphatics. A blister is an example of serous inflammation. If the inflammation continues to intensify, the exudation is altered in character—it becomes thicker, turbid, and very coagulable. It contains white cells and fibrin-elements, and coagulates in the tissues, because some of the leukocytes break up and set free fibrin-ferment, and fibrin-ferment causes the union of calcium and fibrinogen and the formation of fibrin. This fluid is known as "lymph," or plastic exudation, and when it is present we speak of the condition as "plastic inflammation." The lymphatics endeavor to absorb the fluid, but become occluded by coagulation, and the area they drain becomes swollen, hard, and "brawny." Lymph can be seen in the anterior chamber of the eye in cases of plastic iritis. The slighter the inflammation the less albuminous is the fluid—the more intense the inflammation the more albuminous is the fluid. The focus of an inflammation usually feels brawny because of coagulation of a highly albuminous exudate—the periphery of an inflammation is soft and edematous because of the presence there of thin and non-coagulable exudate. Inflammatory lymph contains proteids and other substances. "Of these the more important are ferments, the results of proteolysis (notably fibrin and its precursors and peptones), and in many cases mucin, together with bactericidal substances, and, where bacteria are present, the products of their growth."[1] The amount of the exudation varies with the violence of the irritation, the nature of the irritant, the general condition of the organism, and the state of the tissues which are involved. In dense tissue (bone, periosteum, etc.) the exudation is scanty. In loose tissues (subcutaneous tissue) it is profuse. Profuse exudation may take place into a joint, the pleural sac, the peritoneal cavity, or the pericardium.

Does the plasma leave the vessels as a simple filtrate? Some maintain that it does. Heidenhain and others claim that it does not, and believe that the endothelial cells play an active part in the process. Heidenhain likens exudation to secretion, because some materials from the plasma pass out and others do not. Adami is inclined to agree with Heidenhain, that the epithelium plays "not a passive, but an active rôle." It is a question if open spaces do or do not exist between the endothelial cells, but the existence of such spaces has not been proved.

[1] Adami, in Allbutt's *System of Medicine.*

Diapedesis and Migration.—Even early in an inflammation some few white corpuscles pass through the vessel-walls; but when the inflammation is well established large numbers, and when it is severe vast hordes, pass into the

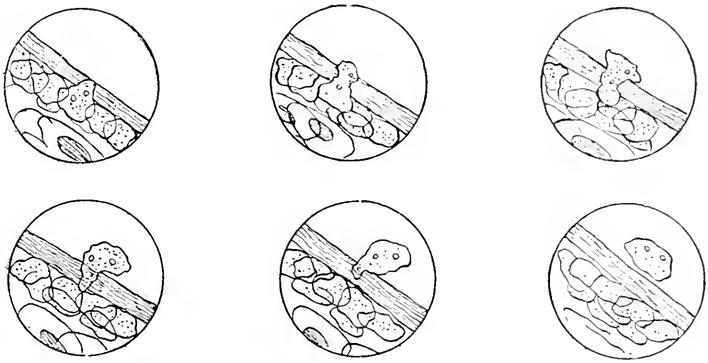


FIG. 25.—Stages of the migration of a single white blood-corpuscle through the wall of a vein (Caton).

perivascular tissues. This process is known as "diapedesis," or "migration" (Fig. 25). The leukocytes throw out protoplasmic arms, insert themselves between the cells of the walls of the vessel, and pull themselves through by their power of ameboid movement (Fig. 26). Most observers claim

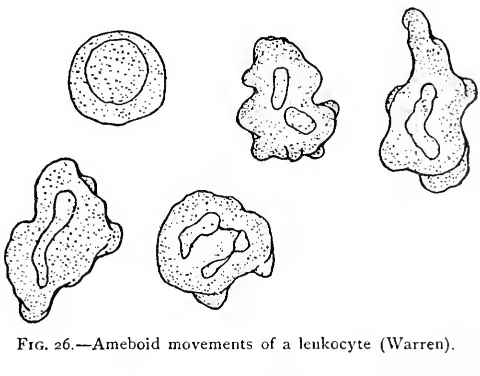


FIG. 26.—Ameboid movements of a leukocyte (Warren).

that they do not pass through existing open doors, but form openings which close after them. This is readily accomplished, because the vessel-wall is itself damaged, weakened, and convoluted. Others claim that stomata exist between

the epithelial cells, the vessel-wall being porous like a filter. The escape of leukocytes takes place chiefly from the venules, though some migrate through the capillaries and even the arterioles (Fig. 25).

The leukocytes are influenced to move toward the damaged tissue by the attractive force known as positive "chemiotaxis," a force which draws them toward invading bacteria, to regions of irritation, and to areas of tissue-death. Leukocytes may move from very virulent organisms, influenced by what is known as negative chemiotaxis. The migration of a leukocyte requires but a short time. Fig. 25 shows the migration of a white blood-cell through a vein-wall, the process requiring one hour and fifty minutes. In very acute inflammations, red corpuscles pass into the tissues. Red corpuscles are not capable of ameboid movements, and they escape through damaged areas in the capillary walls. The white corpuscles usually greatly increase in number in the blood of a person who has an acute inflammation (leukocytosis), and the blood-making organs, such as the spleen and lymphatic glands, are often enlarged. The blood-plaques, or third corpuscles, are found to be present in increased numbers. These blood-plaques are not seen in moving blood, but are found in blood-clot, their usual proportion to red cells being as 1 to 20, and they are especially numerous at the height of fever-processes and during convalescence from an extensive abscess.

Changes in the Perivascular Tissues.—The liquor sanguinis which exudes during an acute inflammation coagulates unless prevented by virulent bacteria. It has often been asserted that exudation is Nature's method of supplying nutriment to the cells of the damaged region. Adami points out the apparently contradictory observation that the amount of exudate is in direct proportion to the rapidity of cell-destruction, but nevertheless concludes that exudation stands in close relation with cell-proliferation.[1] From whatever cause, tissue-cells multiply, and this process is known as "cell-proliferation."

When a tissue is injured it inflames, and, as Adami points out, the reaction to injury is an attempt to repair injury.

Irritation may lead to degeneration and death of cells; it may lead to growth and multiplication. In many cases both processes are active in the acute stage, the cells at the focus of the inflammation undergoing degeneration and destruction,

[1] Allbutt's *System of Medicine.*

and those at the boundary undergoing growth and proliferation.[1]

If tissue-cells have been seriously damaged, they perish, and new cells are required to replace them. The inflammatory process has led to exudation of plasma and migration of leukocytes into the perivascular tissues. The connective-tissue cells multiply and produce young cells, which are known as "fibroblasts," and which eat up many leukocytes. The migrated leukocytes in part move out of the inflamed area, each one carrying within it some tissue-débris, are in part eaten up by the fibroblasts, in part undergo degenerative changes, and a very few of them multiply and give rise to fixed cells. This mass of young cells, taking origin chiefly from the fixed cells, but partly from the leukocytes has been called embryonic tissue, because of a fancied resemblance to the cells of the embryo. It has also been called indifferent tissue, because of the belief that it could be converted indifferently into various tissues according to circumstances. It is also spoken of as inflammatory new formation.

An exudation may be absorbed by the lymphatics. It may be converted into pus if infected with pyogenic bacteria, or be replaced by cells from the proliferation of fixed tissue-cells and leukocytes, the cellular mass being subsequently vascularized by the extension into it of capillary loops derived from adjacent capillaries. When embryonic tissue is filled with blood-vessels, that is to say, when it is vascularized, it is called granulation-tissue. Granulation-tissue is finally converted into fibrous tissue. The above complicated processes, vascular and perivascular, are not accidents nor haphazard freaks, but are Nature's efforts to bring about a cure.

Dilatation is due to the direct effect of the irritant upon the muscle or its nerve-elements. Retardation and stasis are due to paralysis of the vessel-wall, which paralysis causes resistance to the passage of the blood-stream and adhesion of the leukocytes to the vessel-wall. The blood liquor exudes and the leukocytes migrate. Often these efforts of Nature succeed. Acceleration of the circulation may succeed in washing away an irritant from the vessel-wall. By bringing quantities of blood to the part it secures copious exudation of plasma. The exudation may wash away and remove irritants from the tissues, and the germicidal blood-liquor may destroy bacteria in the damaged area. The migration of corpuscles may prove of great ser-

[1] Adami, in Allbutt's *System of Medicine*.

vice. The leukocytes surround an area of infection and tend to limit its spread. Leukocytes have phagocytic properties, and energetically attack and often destroy bacteria, and they furnish antitoxins which antagonize and may neutralize the poisons produced by micro-organisms. Leukocytes aid in separating dead tissue from living, and remove tissue-débris from the area of inflammation. Further, they may contribute to repair, by undergoing multiplication and furnishing young cells which are not wandering, but fixed. The multiplication of the fixed connective-tissue cells leads to the formation of fibroblasts, and fibroblasts are converted into fibrous tissue, which effects permanent repair (these changes will be alluded to again in the chapter on Repair).

Nature may fail in her efforts. For instance, an enormous exudate increases stasis and may cause such tension that gangrene results.

Inflammation in Non-vascular Tissue.—A type of non-vascular tissue is the cornea, and the cornea can inflame. The healthy cornea contains no blood-vessels. It is formed of many layers of fibers, each layer running parallel with the corneal surface and forming angles with the fibers of the adjacent layers. Between the layers are communicating lymph-spaces containing connective-tissue cells. When the cornea inflames the episcleral vessels usually dilate and pour out exudate, and the fluid exudate and the leukocytes enter into the corneal lymph-spaces. The exudate coagulates and cell-multiplication ensues as in any other inflammation. In mild inflammations the episcleral vessels may not dilate. Leukocytes, from the lymph-spaces, reach the seat of injury in small numbers, but the fixed cells and possibly some leukocytes multiply. Nancrede points out that in trivial inflammation which injures but does not destroy the epithelium leukocytes may not go to the seat of inflammation, the only change being enlargement and multiplication of corneal corpuscles. If new formation takes place, a permanent opacity mars the cornea as a consequence. When cartilage inflames it becomes filled with leukocytes, which are obtained from the vessels of the synovial membrane or the bone, and changes ensue identical with those previously studied.

Classification of Inflammations.—The various forms of inflammations are—(1) *Simple* or *common*, that which is due to any ordinary traumatic, chemical, or thermal cause, and not to bacteria, such as traumatic periostitis or sun dermatitis. It does not tend particularly to spread. As a rule, the cause of a simple inflammation is momentary in action;

(2) *infective* or *specific*, that which is due to micro-organisms, as the streptococcus of erysipelas. An unsuccessful attempt has been made to charge all inflammations to bacteria. It is true that bacteria can generally be found in inflammatory areas, but that they are the only causes of inflammation is accepted by few. Infective inflammations often tend to spread widely; (3) *traumatic*, which is due to a blow or an injury; (4) *idiopathic*, which is without an ascertainable cause. There is certainly a cause, even if it cannot be pointed out, and the term "idiopathic" means that we do not know the cause; (5) *acute*, which is rapid in course and violent in action; (6) *chronic*, which follows a prolonged course; (7) *subacute*, which is intermediate in violence and duration between acute and chronic; (8) *sthenic*, characterized by high action. Occurs in strong young subjects; (9) *asthenic* or *adynamic*, occurring in the old, the debilitated, and the broken-down. In such an inflammation there is no certain limitation of the inflammation by leukocytes, and there is an indisposition on the part of the tissue-cells to form fibroblasts; (10) *parenchymatous*, affecting the "parenchyma," or active cells of an organ; (11) *interstitial*, affecting the connective-tissue stroma of an organ; (12) *serous*, characterized by profuse non-coagulating exudation, as in pleuritis, or by marked inflammatory edema; (13) *plastic*, *adhesive*, or *fibrinous*, characterized by an exudation which glues together adjacent surfaces, as in peritonitis; (14) *purulent*, *phlegmonous*, or *suppurative*, when the pus cocci are present and multiply; (15) *hemorrhagic*, when the exudate contains many red blood-cells, as in strangulated hernia and in the pustules of black small-pox; (16) *croupous*, when an inflammation produces upon the surface of a tissue a fibrinous exudate which cannot be organized into tissue, and which is due to the action of micro-organisms. An exudate of this character was called by the older surgeons "aplastic lymph." It occurs most usually on mucous membrane; (17) *diphtheritic*, which differs from croupous in the fact that the false membrane is in the tissue rather than upon it; (18) *gangrenous*, an inflammation resulting in death of the part, the gangrene being due to the tension of the exudate or the violence of the poison; (19) *healthy*, when the tendency is to repair; (20) *unhealthy*, when the tendency is to destruction; (21) *latent*, an inflammation which for some time does not announce itself by any obvious symptoms, as the inflammation of Peyer's patches in typhoid fever; (22) *contagious*, when its own secretions can propa-

gate it; (23) *dry*, without exudation; (24) *hypostatic*, arising in a region of passive congestion (as a bed-sore); (25) *malignant*, due to malignant growths; (26) *catarrhal*, affecting mucous membranes; (27) *neuropathic*, due to impairment of the trophic functions of the nervous system, as in perforating ulcer; and (28) *sympathetic* or *reflex*, due to disease or injury of a distant part, as when orchitis follows mumps.

Extension of Inflammation.—Inflammation extends by continuity of structure, by contiguity of structure, by the blood, and by the lymphatics. Extension by continuity is seen in phlebitis. Extension by contiguity is seen when a cutaneous inflammation advances and attacks deeper structures. Extension by the blood is seen in the formation of the small-pox exanthem. Extension by the lymphatics is witnessed in a bubo following chancroid.

Terminations of Inflammation.—Inflammation may be followed by a return of the tissues to health, and this return may take place by delitescence, by resolution, or by new growth. By *delitescence* is meant abrupt termination at an early stage, as when a quinsy is aborted by the administration of quinin and morphin, and the production of a sweat; *resolution* means the gradual disappearance of the symptoms when inflammation has passed through its regular stages; and *new growth* means that an inflammation has lasted a considerable time, with ample blood-supply, and without suppuration has gone on to the formation of fibroblasts, granulation-tissue, and fibrous tissue. Inflammation may be followed by death of the inflamed part, or necrosis. Death of the part may be due to suppuration, ulceration, or gangrene.

The **causes of inflammation** are—*predisposing*, or those residing in the tissues, and rendering them liable to inflame; and *exciting*, or those which directly awake the process into activity. The first may be thought of as furnishing inflammable material; the second may be regarded as sparks of fire.

Predisposing causes are those which impair the general vigor, injure the blood, weaken the tissues, or lower nutritive activities. Among these causes are shock, hemorrhage, nervous irritation, gout, rheumatism, diabetes, Bright's disease, alcoholism, and syphilis. Plethora renders a person liable to sthenic inflammations (those characterized by high action). Tissue-debility renders one prone to adynamic or asthenic inflammations.

Exciting Causes.—The exciting causes of inflammation are

—*traumatic*, as blows and mechanical irritation; *chemical*, as the stings of insects, ivy poison, etc.; *thermal*, heat and cold; and *specific*, the micro-organisms, causing, for instance, tubercular peritonitis or erysipelas.

Some writers insist that every inflammation is due to the action of micro-organisms, but this statement lacks proof. They maintain that inflammation is a destructive microbic process which cannot bring about repair, and that repair only begins when inflammation ends. As Adami points out, the advocates of this view argue that swelling, pain, and discoloration point to the existence of inflammation; that repair can take place when these phenomena are absent, hence inflammation is not present when repair begins. As a matter of fact, swelling, discoloration, and pain are phenomena often but not invariably associated with inflammation; and in inflammation one or all of these phenomena may be absent. Because these signs are not discovered is no proof that inflammation does not exist. We believe that inflammation is not always due to microbes and is not always a destructive process, but may be from the start conservative and reparative. It is the reaction of the tissue to injury and is the first step on the road to repair.[1]

Symptoms of Acute Inflammation.—Inflammation, if at all severe, announces its presence by symptoms which are both *local* and *constitutional*. The local symptoms are heat, pain, discoloration, swelling, and disordered function; the chief constitutional symptom is fever.

Local Symptoms of Inflammation.—The most prominent local symptoms were known centuries ago to the famous Roman Celsus, who stated them as "*rubor, calor cum tumore et dolore*"—redness and heat with swelling and pain. As set forth to-day, the local symptoms are—(1) heat; (2) pain; (3) discoloration; (4) swelling; and (5) disordered function.

Heat is due to the passage of an increased quantity of blood through the damaged area and to the arrival at the surface of the body of warm blood from internal parts. Although an inflamed part may be, and usually is, warmer than the surrounding parts, its temperature is never greater than the temperature of the blood. This increase of heat is especially noticeable when we contrast the feeling of an arm affected with erysipelas with a sound arm; the diseased arm feels much warmer, but still its temperature is not above the general body-temperature. The extremities in health, as is

[1] See Adami's masterly article in Allbutt's *System of Medicine*.

well known, show on the surface a temperature below that of the blood; in an inflamed state their temperature may nearly equal that of the blood. Heat is always present in inflammation of a superficial part. The surgeon examines for heat by placing his hand upon the suspected area and then placing it upon a corresponding portion of the opposite side of the patient, in order to note the contrast. If great accuracy is desired, a surface thermometer is used.

Pain is a constant and a conspicuous symptom. It is due to stretching of or pressure upon nerves from exudate; to irritation of nerves; or to inflammation of the nerves themselves, producing cellular changes. Pain is associated with tenderness (pain on pressure), it is aggravated by motion and by a dependent position of the part, and it varies in degree and in character. In serous membranes it is acute and lancinating, like dagger-thrusts; in connective tissue it is acute and throbbing; in large organs it is dull and heavy; in the bone it is gnawing or boring; in the skin and mucous membrane it is itching, burning, smarting, or stinging; in the urethra it is scalding; in the testicle it is sickening or nauseating; in the teeth it is throbbing; and in inflammation under tense fascia it is pulsatile. Pain in inflammation after presenting itself in one form may change in character. If a pain becomes markedly throbbing, suppuration may be anticipated. Pain does not always occur at the seat of trouble, but may be felt at some distant point. This is known as a "sympathetic" pain, and means that a nervous communication exists between the inflamed part and a distant area, a nerve-trunk referring pain to its peripheral distribution. Tenderness, however, is detected at the seat of trouble.

Pain of hepatitis is often felt in the right shoulder. Pain at the point of the shoulder is felt also in gall-stones and in cancer of the liver. The pain arises in filaments of the pneumogastric from the hepatic plexus, which filaments reach the spinal accessory, pain being expressed in the branches of the spinal accessory which supply the trapezius and communicate with the third and fourth cervical nerves.[1]

Pain of coxalgia is often felt on the inside of the knee, because the obturator nerve, which sends a branch to the ligamentum teres, also sends a branch to the interior and to the inner side of the knee-joint.

Inflammation of an eye with increased tension causes

[1] Embleton's view in Hilton on *Rest and Pain*, a book every student should read.

brow-ache. Inflammation of the neck of the bladder causes pain in the head of the penis. Inflammation of a testicle causes pain in the groin. Renal calculus and pyelitis cause pain in and retraction of the testicle, and pain in the loin, groin, or thigh.

If the covering of an organ is involved, pain becomes more violent; for instance, hepatitis becomes much more painful when the perihepatic structures are attacked. Inflammation without pain is known as "latent" (as the inflammation of Peyer's patches in typhoid). The sudden disappearance of inflammatory pain, when not due to opiates, suggests the possibility of gangrene, because analgesia exists in gangrene. The characteristics of inflammatory pain are that it comes on gradually, has a fixed seat, is continuous, is attended by other inflammatory symptoms, and is increased by motion, by pressure, and by the hanging down of the part. If there be no tenderness in a part, the source of the pain is not local inflammation; but tenderness may exist when there is no local inflammation, as in pain referred from a distant part. Pain of inflammation does not correspond to an exact nervous distribution. If pain corresponds exactly to the area of a nerve's distribution, the cause of it is acting on the nerve-trunk or on its roots. If the cutaneous surface is involved, the lightest touch causes pain. If touching the skin produces no pain, but deep pressure does produce it, the deeper structures are the source. Pain in muscle and ligament is developed by motion: in muscle, by contraction, but not by passive movements with the muscle relaxed; in ligament pain is developed by active or passive movements which stretch the ligament. If, for example, a man with a stiff neck has pain on the right side of the back of his neck on voluntarily turning his face toward the left shoulder, but is without pain when his face is turned by the surgeon, who, conversely, induces pain by turning the patient's face far to the right, this condition indicates the trouble to be muscular. If, however, no pain arises on turning the face to the right, but it is manifest on turning the face actively or passively to the left, the pain is in those ligaments which stretch when the face is turned to the left.[1] In inflammation of the synovial membrane gentle passive motion in any direction causes pain.

The pain of colic differs from that of inflammation. It is sudden in onset, intermits, recurs in paroxysms, and is relieved by pressure. The pain of inflammation is gradual in

[1] *Surgical Diagnosis*, by A. Pearce Gould.

onset, is continuous, and is made worse by pressure. The pain of neuralgia is often preceded by cutaneous anesthesia of the skin of the part, is very paroxysmal, comes on suddenly, darts through recognized nerve-areas, lasts some hours, and is apt to recur at a certain hour. It presents no general tenderness, as does inflammation, but we may find several points which are acutely sensitive to pressure (Valleix's *points douloureux*). The tender spots of Valleix are met with in *inveterate* neuralgia, and occur at points where nerves "pass from a deeper to a more superficial level, and particularly where they emerge from bony canals or pierce fibrous fasciæ."[1]

Pain is often of great value by calling attention to parts diseased; but it may be a terrible evil, racking the organism and even causing death. If pain continue long, it becomes in itself formidable: it prevents sleep, it destroys appetite, and it deteriorates the mind, and one of the surgeon's highest duties is to relieve it. The physiognomy or expression of physical pain presents the following characteristics: Heavy fulness about the eyes, and dropping of the angles of the mouth, added to appearances due to anemia, widespread tremor, etc. The absence of the physiognomy of pain in a person who complains of great agony is a strong indication that the patient exaggerates the gravity of his sufferings or deliberately deceives.

Discoloration arises from determination of blood to the part; hence the more vascular the tissue the greater the discoloration. A non-vascular tissue presents no discoloration, though we usually find discoloration adjacent in the zone of blood-vessels which furnish the tissue with nutriment. Discoloration is most intense at the focus or center of inflammatory action. Discoloration varies in tint and in character according to the tissue implicated and the nature of the inflammation. It may be circumscribed or diffuse. Arborescent redness means a distribution in dendritic lines. Linear discoloration signifies redness running in straight lines, as in phlebitis. Punctiform discoloration occurs in points, and is due to vascular rupture. Maculiform redness resembles an ecchymosis or blotch. Dusky discoloration points to suppuration.

Inflammation of the throat and skin produces scarlet discoloration; inflammation of the sclerotic coat of the eye and of the fibrous coat of muscle produces lilac or bluish discoloration; inflammation of the iris produces brick-dust, gray-

[1] Anstie, *Neuralgia and Diseases which Resemble It.*

ish, or brown discoloration; erysipelas causes a yellowish-red discoloration; secondary syphilis causes a copper-hued discoloration; and tonsillitis causes a livid discoloration. A tubercular ulcer is of a purple color on the edge. Gangrene is shown by a black discoloration. A scorbutic ulcer is surrounded by an area of violet color.

Redness as a sign of inflammation must be permanent and joined with other symptoms. Redness due to inflammation disappears on pressure, but returns as soon as the pressure is removed. If redness is due to staining of the surface by dye, pigmentation, or extravasation of blood, pressure will not blanch the spot. If on taking off pressure the redness of inflammation rapidly returns, the circulation is active; if, on the contrary, it very slowly reappears, the circulation is very sluggish and gangrene is threatened. Subcutaneous hemorrhage gives rise to a purple-red color which does not fade when subjected to pressure. Stains of the surface by dyes fail to disappear on pressure, are distributed over a considerable surface, show a hue which is uniform throughout, are obviously superficial, are not associated with other signs of inflammation, and can be washed away.

A. Pearce Gould, in his excellent little work upon *Surgical Diagnosis*, tells us that the color of a hyperemic surface may furnish important information. Lividity may mean failure of the heart and lungs, or simply venous congestion in the part. In lividity from obstruction of the lungs or heart the color slowly returns after pressure has driven it out. In lividity due to local congestion the color quickly returns when pressure is released and the dilated veins are often distinctly visible.

Swelling or *tumefaction* arises in small part from vascular distention, but chiefly from effusion and cell-multiplication. The more loose cellular material a part contains, the more it swells; hence the eyelids, scrotum, vulva, tonsils, glottis, and conjunctivæ swell very largely when inflamed. A swelling is soft or edematous when due to uncoagulable effusion; is brawny and doughy when due to coagulated effusion; is hard and elastic when produced by proliferating cells. Swelling may do good by unloading the vessels and acting like a blister or local bleeding, or it may do great harm by pressing upon the vessels and cutting off the blood-supply. Swelling of the conjunctiva, or chemosis, may cause sloughing of the cornea, and swelling of the prepuce may cause gangrene. A swelling may do harm by obstruction of a natural passage, as in edema of the glottis, when the larynx

becomes blocked; or by compression of a normal channel, as in the swelling of the perineum, when the urethra is compressed. A swollen area may be covered with blisters or blebs. This condition is noted particularly in burns.

Disordered function is always present in inflammation. It may be manifested by *increased tenderness* or sensibility, a slight touch, it may be, producing torturing pain. Parts almost or entirely destitute of feeling when healthy (as tendons, ligaments, and bones) become highly sensitive when inflamed. It may be manifested by *increased irritability*. In dysentery the colon constantly contracts and expels its contents; the stomach does likewise in gastritis; and the bladder acts similarly in cystitis. Spasmodic twitching of the eyelids occurs in conjunctivitis, and twitching of the muscles in fracture and after amputation.

Impairment of Special Function.—In inflammation of the eye, when an attempt is made to look at objects, the lids close spasmodically, and even a little light causes great pain and lachrymation (photophobia). In inflammation of the ear noises cause great suffering, and even when in a quiet room the patient has subjective buzzing and roaring sounds in his ears (tinnitus aurium). In coryza the sense of smell, in glossitis the sense of taste, in dermatitis the sense of touch, and in laryngitis the voice may be lost. In inflammation of the brain the mind is affected; in arthritis the joints can scarcely be moved; and in myositis it is difficult and painful to employ the muscles.

Derangement of Secretions.—In dermatitis the sweat is not thrown off; in hepatitis bile is not properly secreted; and in nephritis urea is not satisfactorily removed. The secretions may undergo important changes of composition. The sputum in pneumonia is rusty, and dysentery causes a discharge of bloody mucus (Gross).

Derangement of Absorbents.—In the height of an inflammation the absorbents are blocked and clogged by coagulated fibrin, and they cannot perform their offices.

Constitutional symptoms of acute inflammation may be absent, and often are in moderate or limited inflammations; but in severe, extensive, or infective inflammations the symptom-group known as *fever* is certain to exist. This is known as symptomatic, sympathetic, or inflammatory fever, and it arises in non-septic cases from the absorption of aseptic pyrogenous exudate and in microbic inflammations from absorption of pyrogenous toxic products of bacterial action. In young and robust individuals an acute non-microbic

inflammation causes a fever characterized by full, strong pulse, flushed face, coated tongue, dry skin, nausea, constipation, and possibly acute delirium (the sthenic type of the older authors). In broken-down and exhausted individuals an ordinary inflammation, and in any individuals a bacterial inflammation, may cause a fever with typhoid symptoms (the typhoid, asthenic, or adynamic type). In inflammatory conditions the leukocytes are markedly increased in number, the condition being spoken of as leukocytosis or transient leukocythemia. Blood-plaques are also increased. The fibrin-ferment is obtained from the white corpuscles; it is liberated as the corpuscles break up in the exudate, and acting on the liquor sanguinis causes the union of calcium and fibrinogen and the formation of fibrin. The absorption of fibrin-ferment many believe causes aseptic fever (page 115). Inflammatory blood contains an increased amount of albumin and salts. If a person with inflammatory fever is bled, the blood coagulates rapidly, the clot sinks, and there is found on the surface a cup-shaped coat, made up of liquor sanguinis and white cells, known as the "buffy coat;" but this is not a sign of inflammation, and occurs normally in the blood of the horse. The buffy coat forms when blood contains a great number of leukocytes, because these leukocytes sink more slowly than do the red corpuscles. Cupping occurs because the white corpuscles sink more slowly by the sides of the tube than far from the sides.

Chronic Inflammation.—This condition progresses slowly and does not produce symptoms of severity either in the part or the body at large.

Causes.—Blood-diseases, as rheumatism and gout; infective diseases, as tuberculosis and syphilis; retained pus in an ill-drained abscess; blockage of the duct of a gland; the retention of a foreign body in a part; the flow of an irritant secretion (as saliva from a fistula); repeated identical traumatisms of an occupation, etc. W. Watson Cheyne tells us chronic inflammation is not due to the ordinary pyogenic organisms (see Cheyne's article in Treves's *System of Surgery*).

Tissue-changes.—These changes are practically the same as in acute inflammation, but take place far less rapidly. It is maintained by Cheyne and others that typical granulation-tissue does not form, the tissues of the part being replaced by fibrous tissue. The amount of fibrous tissue produced is relatively very great. This tissue may cause permanent thickening, or may contract and thus diminish the size of a

part. Contraction is very considerable in cirrhosis of the liver and in interstitial nephritis.

Symptoms.—Pain varying in intensity and character; tenderness; great swelling, which in some cases is followed by shrinking, and is usually indurated or brawny; sometimes heat, rarely discoloration unless the skin is itself inflamed. There are no constitutional symptoms attributable purely to the inflammation. If there are such symptoms, they are due to the disease which induced the inflammation or to interference with the function of an organ because of the fibrous mass. (For treatment of chronic inflammation see articles upon special regions and particular structures.)

Treatment of Acute Inflammation.—The first rule in treating an inflammation must be to remove the exciting cause. If this cause is a splinter in the part, take out the splinter; if it is a foreign body in the eye, remove the foreign body; if urine is extravasated, open and drain; take off pressure from a corn; pull out an ingrown nail; and remove microbes from an infected area by exposing, irrigating, and applying antiseptics. The rule, remove the cause, applies to a chronic as well as to an acute inflammation. If the cause of an inflammation was momentary in action (as a blow), we cannot remove it, for it has already ceased to exist. After removing the cause, endeavor to bring about a cure by local and constitutional treatment.

Local Treatment of Inflammation.—It must be remembered that the division of inflammation into stages is natural, and not artificial, and that a remedy which does good in one stage may do harm in another. Certain agents are suited to all stages of an inflammation, namely, *rest* and *elevation.*

Physiological *rest* is of infinite importance, and is always indicated in acute inflammation. In the exercise of function blood is taken to a part and an existing inflammation is aggravated. Further, as Billroth has pointed out, rest prevents the dissemination of infection, because motion exposes fresh surfaces to inoculation and breaks down protective barriers of leukocytes. Its principles were first thoroughly studied by Hilton.[1] The means of securing rest differ with the structure or the part diseased. When rest is used, do not employ it too long. *Rest in bed* diminishes the amount of blood sent to an inflamed part and lessens the force of the circulation, hence it antagonizes stasis. It has been shown that the heart beats at least fifteen times per minute less when the

[1] *Lectures upon Rest and Pain.*

patient is recumbent than when he is erect. The saving of strength and the benefit of the local condition are thus seen to be enormous. In fact, the heart saves at least twenty-one thousand beats a day. In every severe inflammation insist on the patient going to bed. In *cerebral concussion* rest must be secured by quiet, by darkness, by the avoidance of stimulants and meat, by the application of ice to the head, and by the use of purgatives to prevent reflex disturbance and the circulation of poisons in the blood. In *inflamed joints* rest must be obtained by proper position, associated in many cases with the adjustment of splints or plaster of Paris, or the employment of extension.

In *pleuritis* partial rest can be secured by strapping the affected side with adhesive plaster or by using a bandage or a binder to limit respiratory movements. In *fractures* Nature procures rest by her splints—the *callus*—and the surgeon procures rest by his splints—firm dressings, or extension. In *cancer of the rectum* and intractable rectitis, a colostomy secures rest for the inflamed and damaged bowel. In *enteritis* opium gives rest to the bowel by stopping peristalsis. In *cystitis* rest is obtained by opium and belladonna, which paralyze the muscular fibers of the bladder. The use of the catheter gives rest to the bladder by removing urine. A cystotomy allows complete rest by permitting the bladder to suspend its function as a reservoir of urine. In cystitis from *vesical calculus* rest is obtained by cutting or crushing the stone. In *inflamed mucous membrane* rest from the contact of irritants is secured by touching the membrane with silver nitrate, which forms a protective coat of coagulated albumin. Opening an *abscess* gives its walls rest from tension. In *inflammations of the eye* light must be excluded to obtain complete rest, but tolerably satisfactory rest is given in some cases by the use of glasses of a peacock-blue tint. In *aneurism* the operation of ligation cuts off the blood-current and gives rest to the sac. In *hernia* the operation gives rest from pressure. Instances of the value of rest could indefinitely be multiplied.

Relaxation is in reality a form of rest, and consists in placing the part in an easy position. In *synovitis* of the knee semiflexion of the knee-joint lessens the pain. In *muscular inflammations* relaxation relieves the pain.

Elevation partly restores circulatory equilibrium. A *felon* is less painful when the hand is held up in a sling than when it is dependent. A *congestive headache* is worse during recumbency. A *gouty inflammation* in the great toe is more

painful with the foot lowered than when it is raised. A *tooth-ache* becomes worse on lying down.

Certain agents are suited to the stage of vascular engorgement, increased arterial tension, and beginning effusion. These agents are—(1) local bleeding or depletion; (2) cutting off the blood-supply; and (3) cold.

Local bleeding, or *depletion*, is the abstraction of blood from the inflamed area. This abstraction relieves circulatory retardation and causes the blood to move rapidly onward; the corpuscles clinging to the vessel-walls are washed away, the capillaries shrink to their natural size, and the exudate is absorbed. In other words, local blood-letting increases the rate of the circulation, though not its force.

The methods of bleeding locally are—(*a*) puncture; (*b*) scarification; (*c*) leeching; and (*d*) cupping.

Puncture is recommended in inflammation, not only because it abstracts blood locally, but also because it gives an exit to effusion under fibrous membranes. It is very useful in relieving tension—for instance, in epididymitis. It is performed with a tenotome and with aseptic precautions. If numerous punctures are made, the procedure is termed "multiple puncture." This is very useful when applied to the inflamed area around a leg-ulcer. The late Prof. Joseph Pancoast was very fond of employing multiple punctures, designating the operation "the antiphlogistic touch of the therapeutic knife."

Scarification or Incision.—By means of scarification we bleed locally, evacuate exudates, and relieve tension. One cut or many cuts may be made, and these cuts may be deep or may not go entirely through the skin, according to circumstances. Multiple incisions are useful when applied to inflamed ulcers, ulcers in danger of gangrene, and to almost any condition of great tension. Free incision is of great value in periostitis and in threatened gangrene. In osteomyelitis the medullary canal must be promptly opened.

Leeching.—Leeches must not be applied to a region plentifully endowed with loose cellular tissue, as great swelling and discoloration are sure to ensue. These regions are the prepuce, labia majora, scrotum, and eyelids. Leeches should never be applied to the face (because of the scar), near specific scars or inflammations, nor over a superficial artery, vein, or nerve. A leech is best applied at the periphery of an inflammation and between an inflammation and the heart. To leech at the inflammatory focus only aggravates the trouble. Before applying leeches, wash the part and

shave it if hairy. If the leeches will not bite, smear the part with milk or with a little blood. In using a leech, place it on the skin under a glass tube, or an inverted wine-glass. The thick end of the leech is the tail, and this must be placed in the glass first. Never pull off a leech: let it drop off; and if it refuses to do so, sprinkle it with salt. After removing a leech, employ warm fomentations if continued bleeding is desired. Sometimes the bleeding persists, but this may be arrested by styptic cotton and pressure. In some rare cases the bleeding continues in spite of pressure. This is due to the fact that the tissue contains a considerable quantity of a material from the throat of the leech, which material prevents coagulation of blood. In such a case excise the bite and the area of tissue adjacent to it, and suture the wound. Leeching leaves permanent triangular scars. The Swedish leech, which is preferred to the American, draws from two to four drams of blood. After a leech has been removed, if we desire to use it again, place it in salt water. This causes it to vomit the blood which it has taken up. Leeching has both a constitutional and a local effect. It is at the present time used comparatively rarely, but it is employed by some practitioners over the spermatic cord in epididymitis, on the temple in ocular inflammation, and over the right iliac region to relieve the pain in mild cases of appendicitis.

Cupping.—Dry cups deviate blood from a deeply placed inflamed area to the surface. Wet cups actually remove blood.

Dry Cups.—Dry cups are applied without first incising the skin. One or many may be applied. A special instrument is sold in the shops for the performance of dry cupping. It consists of a glass bell, with a globular and hollow top of rubber. The rubber bulb is emptied of air by squeezing, the glass bulb, the edges of which have been greased, is pushed upon the skin and the compression is relaxed upon the bulb. A partial vacuum is created, and an area of skin and subcutaneous tissue full of blood rise up into the glass bell.

Cupping can be easily performed by means of a tumbler. The edge of the glass is greased; a bit of blotting-paper wet with alcohol is placed in the bottom of the tumbler and lighted. After a brief period the glass is inverted and placed upon the skin, which has been dampened with warm water. As the air in the glass cools the tissues rise up into the partial vacuum.

Wet Cups.—Wet cups draw blood, and the skin should be

cleansed before they are applied. In wet cupping apply a cup for a moment, remove it, incise or puncture the skin, and replace the cup to draw the requisite amount of blood. Incisions may be made by a lancet or scarificator, a cup being then applied. An excellent scarificator is shown in Fig. 27. In this instrument concealed blades are thrown out by touching a spring. Baron Heurteloup devised an instrument (Fig. 28) in which the incision is made by a scarificator. The blood is drawn by a pump, the tube being placed upon the cut area and the withdrawal of the piston creating a vacuum. This instrument is known as the "artificial leech." After scarification and the application of the cup, the partial vacuum draws blood into the cup; when the surface ceases to bleed, the cup is removed, and if further bleeding is thought desirable, the clots are wiped away and the cup is again applied, and after its removal warm fomentations are used (Cheyne and Burghard). Wet cupping is of value in pleuritis, pericarditis, and nephritis.

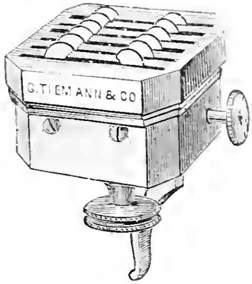


FIG. 27.—Scarificator.

Cutting off the Blood-supply.—Onderdonk, of New York, in 1813 recommended ligation of the main artery of a limb

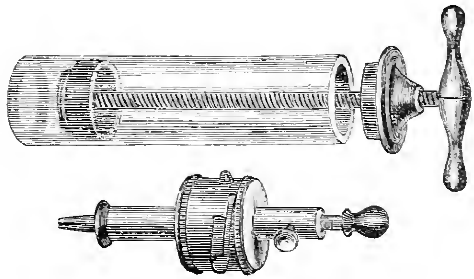


FIG. 28.—Heurteloup's artificial leech.

for the cure of inflammation in important structures supplied by the vessel. The procedure was warmly advocated by Campbell, of Georgia, for the treatment of gunshot-wounds of joints. This plan of treatment is now not to be considered for a moment; antisepsis furnishes us with a safer and more certain plan. Vanzetti, of Padua, advocates digital pressure to cut off the blood-supply to an inflamed part.

Cold is a very powerful and useful agent if used judiciously and applied at the proper time. It is valuable because of its reflex effect upon the vessels of the inflamed area rather than because of direct action upon the cells of a part. It should be used early in the case, before stasis occurs. It is not to be used in the later stages of inflammation, for it will then only aggravate the existing state—in fact, when there is considerable exudation cold does no good.

Cold acts by constricting the vessels of a hyperemic area, thus lessening the amount of blood sent to the part, antagonizing stasis, and preventing the exudation of fluids. Further, it prevents the migration of leukocytes, retards cell-proliferation, relieves pain and tension, and lowers temperature. If cold is too intense, if it is kept too long applied, if it is used late in an inflammation, if it is used upon an old or feeble patient, when there is much exudation or a condition of tissue strangulation, it does actual harm. It lessens the nutritive activity of cells, constricts the lymph-spaces and channels, favors stasis, and hence lowers the vitality of the tissues. If the parts are constricted, as in hernia, or compressed by a large exudate, or fed by diseased blood-vessels, cold may cause gangrene. Nancrede, in his *Principles of Surgery*, points out that in an inflammation stasis soon arises at the focus of the inflammation, and there is an area of stasis surrounded by a zone of hyperemia. Cold benefits the hyperemic zone but aggravates the stasis. Nancrede cautions us as follows: "Judgment is therefore requisite to decide whether the evil at the focus will not outweigh the good exerted at the periphery.[1] Nancrede further points out that cold must not be used intermittently; but if employed at all, must be continuously applied. If cold is applied intermittently, there will be a reaction whenever it is removed, and this reaction causes increased hyperemia. Hence, cold must be "continued in action to prevent reaction." If during the employment of cold the skin becomes purple and congested and the circulation feeble, at once discontinue the use of it, as its continuance will be dangerous.

Cold may be used as wet cold or as dry cold.

Wet Cold.—Wet cold is easily applied, but it is much more depressing than dry cold, is likely to produce discomfort, macerates the skin, and may lead to the formation of excoriations, etc. A part can be subjected to wet cold by the application of evaporating fluids or the use of a siphon.

[1] *Principles of Surgery.*

When wet cold is used inspect the part at frequent intervals, and discontinue the treatment if evidences of stasis become positive. Evaporating fluids are extensively employed. If such a fluid is used, never cover the part with a thick dressing. If this should be done, the fluid will not evaporate with sufficient rapidity to produce cold. A piece of thin muslin or flannel should be moistened with the fluid and laid upon the part, and be kept constantly moist by the application from time to time of small quantities of the liquid. Lead-water and laudanum is used extensively, and probably owes its chief value to the fact that it produces cold on evaporation. Lead-water and laudanum is composed of ℥j of laudanum, ℥j of liquor plumbi subacetatis, and 1 pint of water. Liquor plumbi subacetatis dilutus may be used without laudanum. It is thought that the addition of laudanum tends to allay pain. A solution of ammonium chlorid may be used in the strength of ℥j of the drug to 2 quarts of water. If ammonium chlorid is used for more than a short period of time, it is prone to cause the formation of blisters which are irritable and painful. Cheyne and Burghard use the following formula: $\frac{1}{2}$ ounce of ammonium chlorid, 1 ounce of alcohol, and 7 ounces of water. Plain spring water, iced water, or a mixture of alcohol and water may be used. The *siphon* is occasionally used. If there is a wound, the fluid must be aseptic or antiseptic. In conjunctivitis, cold is applied to the eye by means of linen or muslin soaked in iced water laid upon the lid, and frequently changed.

To apply wet cold by means of a siphon, the part is covered with one layer of wet linen or muslin and is laid upon a rubber sheet folded like a trough and emptying into a bucket. A vessel filled with cold water is placed upon a higher level than the bed. A wet lamp-wick is now taken, one end is inserted into the water of the vessel, and the other end is laid upon the part. Capillary action and gravity combine to keep the part moist. A rubber tube may be used instead of a wick. If a tube is employed, tie it in a knot or clamp it so that the fluid is delivered drop by drop (Fig. 29). Ordinary water or iced water can be used. If the water be too warm, it can be reduced to about 45° F. by adding 1 part of alcohol to every 4 parts of water. A mixture of 5 parts of nitrate of potassium, 5 parts of chlorid of ammonium, and 16 parts of water produces great cold.

Dry cold is more manageable and more generally useful than wet cold. It is applied by means of a rubber bag or a bladder filled with ground or finely cracked ice, several folds

of flannel being first laid over the part. The flannel collects the moisture from the "sweating" bag and thus prevents maceration of the skin. Further, it saves the tissue from being subjected to too much direct cold and enables us to obtain the beneficial reflex effect. The ice-bag of India rubber is widely used. We can venture to apply by means of the ice-bag a greater degree of cold than it is proper to apply by the use of fluids, as dry cold is not so likely to induce gan-

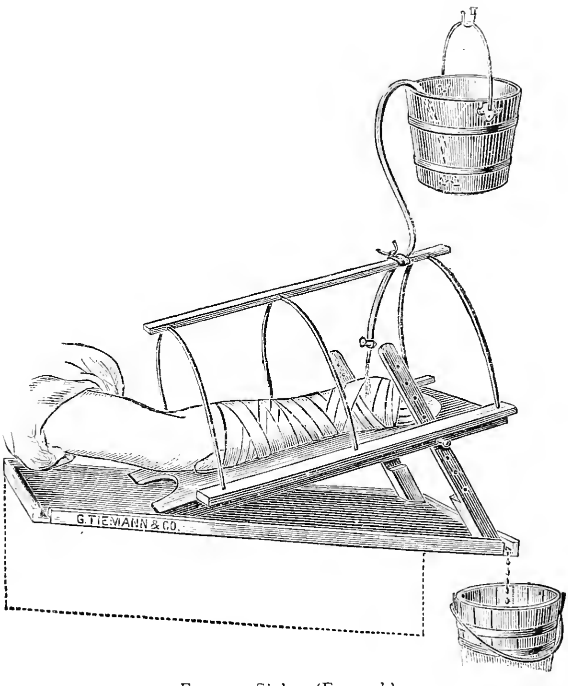


FIG. 29.—Siphon (Esmarch).

grene as is moist cold. If there is much tenderness, the weight of an ice-bag causes pain, and it is best to suspend it from a frame, so that it lightly touches the part. The frame is the same as is used to keep the bedclothes from a fractured leg, and is made from barrel hoops (Fig. 143). During the time an ice-bag is being used the part must be inspected at brief intervals to see that the circulation is not unduly depressed. The ice-bag is frequently used in joint-inflammation, in intracerebral inflammation, in the early stage of appendicitis, in epididymitis, and in acute

myelitis. If a joint is sprained, the immediate application of an ice-bag is of great service. A part can be encircled with a rubber tube through which iced-water is made to flow (Fig. 30). Even when this apparatus is used the part should first be wrapped in flannel. Leiter's tubes, which are tubes of lead made to fit various regions and which carry a stream of cold water, can also be used. A piece of flannel must be placed between the tube and the skin. The temperature of these tubes can be lowered to any desired degree by lowering the temperature of the circulating fluid. Cheyne and Burghard caution us to use a fluid at a temperature not under 50° or 60° F., to inspect the part every three or four

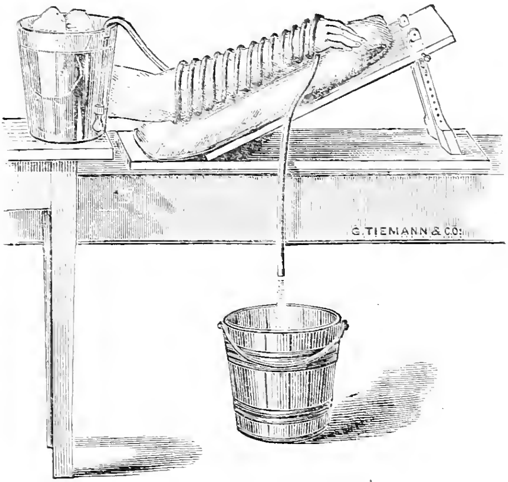


FIG. 30.—The Esmarch cooling coil.

hours, and not to employ the tubes longer than twenty-four hours.[1]

Heat is employed by some early in an inflammation. It is rarely beneficial at this stage, except when applied by a hot-air apparatus for the treatment of an injured joint. It is true that a degree of heat which does not actually destroy the tissues will contract the vessels as does cold; but this degree of heat will not be borne by the patient, and will not be tolerated unless but a limited portion of a superficial part is involved.

Certain agents are suited to the stage of fully developed

[1] *Manual of Surgical Treatment*, by W. Watson Cheyne and F. F. Burghard.

inflammation, when there is a great deal of swelling due to effusion and cell-proliferation. The indication in this stage is to abate swelling by promoting absorption. This is accomplished by (1) compression; (2) the local use of astringents and sorbefacients; (3) the douche; (4) massage; and (5) heat.

Compression is especially useful in fully developed or in chronic inflammation, but it will do good also in the first stage. Compression is of great usefulness; it supports the vessels and causes them to drink up effusion, and it strongly rouses the absorbents. This agent is valuable in most external inflammations with much swelling. In erysipelas of an extremity the part should be elevated and the extremity bandaged from the periphery to the body. In ulcers, especially those with hard and blue edges, the use of Martin's elastic bandage or of straps of adhesive plaster gives decided relief. In chronic inflammation of a joint elastic compression is of great value. In epididymitis, after the acute stage, the testicle may be strapped with adhesive plaster. In lymphadenitis compression by a weight or by a bandage is very generally employed. In fractures compression not only antagonizes spasm, but often combats the swelling and pain of inflammation. Compression must be judicious: it must never be forcible, and it must not be applied to a limb without including the distal extremity (never, for instance, strongly compress the elbow without including the hand, nor the palm without bandaging the fingers). Injudicious compression causes severe pain, and may produce gangrene.

Astringents and Sorbefacients.—Astringents may have direct value in inflammation of the skin, but it is not likely that they have any effect in deep-seated inflammation. When used in evaporating lotions in an earlier stage of inflammation the cold does good rather than the drug. Lead-water and laudanum is extensively employed and it is thought to somewhat allay inflammatory pain. The mixture is certainly serviceable in cutaneous erysipelas. It is very doubtful if lead-water is of any service at any stage of a deep-seated inflammation or in any fully developed inflammation. If used after the first stage it must not be applied as an evaporating lotion, because cold will do harm. Pieces of lint are soaked in the fluid and placed upon the part, and a bandage is applied. The wet lint which has been placed upon the part is covered with oiled silk or a rubber-dam before the bandage is applied. If used in the latter manner, the body heat

is retained in the part. If greater heat is desired, a hot-water bag can be placed outside of the bandage. Lead-water is not used in treating wounds.

Tincture of iodin is astringent, sorbefacient, counterirritant, and antiseptic. It must not be used pure. For application to adults it should be diluted with an equal amount of alcohol, and for children with 3 parts of alcohol. In using iodin, paint it upon the part with a camel's-hair brush and fan it dry, applying one or more coats. The repeated application of iodin to the skin is of great benefit in inflammation of the glands, muscles, tendons, joints, and periosteum. Iodin is apt, after a time, to vesicate, and must not be used in full strength, because it is irritant. It is of especial value in chronic inflammation. In deep-seated inflammation it acts as a counterirritant.

Nitrate of silver is a non-irritating astringent of considerable value in inflammation of mucous membranes. It forms a protective coat of coagulated albumin, and is much used in treating the throat, mouth, and genital organs. In urethral inflammation a proteid compound of silver known as protargol may be used.

Ichthyol is a drug of decided efficiency in reducing inflammatory swelling. It is usually employed in ointments, the strength being from 25 to 50 per cent. It is best exhibited with lanolin. When rubbed in over inflamed glands, joints, and lymphatic enlargements it is of great value. In children a 25 per cent., and in adults a 50 per cent., ointment should be rubbed in thoroughly twice a day. In inflammatory skin-disease, synovitis, thecitis, frost-bite, bubo, chilblain, and in many other conditions, acute or chronic, the use of ichthyol is indicated. The odor of ichthyol is highly disagreeable, and when ordered for a refined person it had better be deodorized. For this purpose Hare uses oil of citronella, ♏xx to ℥j of ointment.

Mercurials.—Blue ointment, pure or diluted to various strengths, is extremely valuable. It is spread upon lint and kept applied over areas of fully developed inflammation. It is especially useful in acutely or chronically inflamed joints, glands, tendons, etc. Blue ointment is strongly irritant, and will soon blister or excoriate a tender skin. It is very beneficial in periostitis, and is employed largely in chronic inflammations.

The *douche* consists of a stream of water falling upon a part from a height. The water may be poured from a receptacle or may run through a tube, and may be either

hot or cold. Alternating hot and cold streams are very popular in inflammations of joints and tendons, especially in chronic inflammation. This mode of application is known as the "Scotch douche." It restores the tone of the blood-vessels and plasma-channels and promotes the absorption of inflammatory exudate. If the part is very tender, the water should be squeezed upon it from sponges. In a sprain of the knee-joint, after a time, when thickening has occurred, pour upon the part daily, from a height, first a pitcherful of very hot water, then a pitcherful of very cold water; then use friction with a hand greased with cosmolin. Hot vaginal douches are largely employed in pelvic inflammations.

Massage is a procedure not frequently enough employed. It is very useful in some acute inflammations, though in these it must be gentle. It is of great service in the treatment of sprains of joints and fractures. It is influential for good in chronic inflammations at the period when rest is abandoned. It acts by promoting the movements of tissue-fluids (blood, lymph, and areolar fluid), stimulating the absorbents, strengthening local nervous control, and thus improving nutrition. Passive motion in joints acts as massage.

Heat may be used continuously or intermittently, and may be either moist or dry. A considerable degree of heat will act like cold and contract the vessels. The degree necessary to cause vascular contraction would not destroy the tissue, but would produce discomfort, which discomfort would become unbearable during the continuance of the application. Therefore, heat is rarely used in the earliest stage of an acute inflammation. It is hard to state exactly when heat should be substituted for cold. Certainly after a day or two it is preferable. The sensations of the patient may be of use in determining this point, and if heat gives comfort it may be used. Moderate heat should be used when inflammation is not very superficial. In a cutaneous inflammation heat usually does harm, because it increases the congestion of an inflamed superficial part. In deep-seated inflammations heat to the surface acts as a revulsive or counterirritant. Thus a poultice to the chest may do good in the first stage of pneumonia, and cauterization of the skin over a joint may benefit an acute synovitis. The use of heat for purposes of counterirritation will be discussed under the head of Counterirritants. A moderate degree of heat applied over a fully developed and not too superficial inflamed area dilates the vessels, especially the veins. Thus

circulation is re-established in an area filled with stagnant blood or blood which is scarcely moving, fluid exudate is absorbed, tension is lessened, the lymph-spaces and vessels distend, and lymphatic absorption becomes active. The application of heat increases the ameboid activity of the leukocytes, phagocytes gather in great numbers and surround an area of infection, and those which have taken up bacteria or tissue-débris hurry away.[1] Heat notably lessens the pain of inflammation. It is often used purely to relieve pain.

The *forms of heat* are—(1) fomentations; (2) poultices; (3) water-bath; and (4) dry heat.

Fomentation is the application to the skin of a piece of flannel containing a hot liquid. A basin is warmed and over the top of the basin a towel is placed. A piece of flannel folded in two or three thicknesses is laid upon the towel and boiling water is poured upon it. By twisting the towel the water is squeezed out. Great care must be taken to squeeze the water out of the flannel, otherwise the skin may be scalded. The hot flannel is laid upon the desired part. A rubber-dam larger than the flannel is placed over it, a mass of cotton is laid upon the rubber-dam, and a bandage is applied. The fomentation must be changed within an hour unless a hot-water bag has been placed outside of the bandage, in which case it need not be changed for two hours or more. The flannel which is dipped into the hot liquid is known as a "stupe." The turpentine stupe is made by wringing out the flannel as above and then putting upon it from 10 to 20 drops of turpentine. Instead of fomenting the part, steam may be thrown upon it. Fomentations are used chiefly for their reflex influence over deep congestions or inflammations. The liquid of a fomentation may, if desired, contain corrosive sublimate, carbolic acid, or other agents. A fomentation containing an antiseptic is known as an antiseptic fomentation. An antiseptic fomentation or, as it is often called, an antiseptic poultice, is made and applied as follows: Gauze is used instead of flannel, and is laid upon the towel over the basin as previously described. A very warm solution of corrosive sublimate (1 : 1000) is poured upon the gauze, the material is partly wrung out, placed upon the part, covered with a rubber-dam, and upon it a hot-water bag is placed. Fomentations are very useful in relieving pain in any stage of an inflammation and act also as counterirritants. Fomentations are used in preference to poultices if there is any probability of a surgical operation

[1] Nancrede, in *Principles of Surgery*.

becoming necessary, because skin to which a poultice has been applied cannot be satisfactorily sterilized.

Poultice or Cataplasm.—A poultice is a soft mass applied to a part to bring heat and moisture to bear upon it. Poultices can be made of ground flaxseed, of slippery-elm bark, of arrowroot, starch, bread and milk, potatoes, turnips, etc. To make a flaxseed poultice, scald a spoon and a tin basin, put the flaxseed into the dry hot basin, and pour upon it boiling water in sufficient quantity to form a thick paste. The proper consistence is found when the mass would stick if it were thrown against a wall. It is now spread to the thickness of a quarter of an inch upon a piece of warm muslin, a free edge being left all around, the edges of the muslin are turned in, and the flaxseed is covered with a bit of gauze to prevent adhesion to the skin. The poultice should be placed upon the part and be covered outside with oiled silk, a rubber-dam, or waxed paper. A mass of cotton is applied outside of the rubber and the poultice is held in place by a bandage or binder. It can be kept very warm for a considerable period by placing upon it a bag filled with hot water. If the hot-water bag is not employed, a poultice should be changed every two hours. Spongiopilin, when moistened with hot water, is a good substitute poultice. Lint soaked with hot water and covered with some impermeable material does very well. The fermented poultice, which was once popular for gangrenous ulcers, was made by sprinkling yeast upon an ordinary cataplasm. The charcoal poultice is made by stirring charcoal into the usual poultice-mass. A poultice containing opium is known as a "sedative" poultice. About gr. ij of opium to the ounce of poultice-mass relieves pain. An antiseptic poultice is made by partly wringing out gauze in a hot solution of corrosive sublimate (1 : 1000), covering it with oiled silk, and placing a hot-water bag upon it to maintain the heat. The antiseptic poultice or fomentation is of great service in removing sloughs from foul wounds and ulcers. It is the only form of poultice which is admissible when the skin is broken. Poultices must not be kept on too long, as they will cause vesication, especially in adynamic conditions. If a poultice is causing vesication, remove it or sprinkle it with powdered oxid of zinc. If suppuration exists or is seriously threatened, do not waste time by using poultices, but incise at once. If suppuration is seriously threatened, incision may prevent it by relieving tension, affording drainage, and permitting of the local use of antiseptics. If pus exists, it can-

not be evacuated too soon. To use poultices and delay incision is often productive of irreparable harm. After incision of a purulent focus it is often useful to apply an antiseptic fomentation. If it seems probable that an operation will become necessary on an area of inflammation, we can use an antiseptic fomentation, but never an ordinary poultice. The ordinary poultice is a vegetable material which adheres to the skin, enters the mouths of glands and follicles, and undergoes decay. It is impossible to cleanse a part thoroughly immediately after it has been poulticed with flaxseed.

Water-bath.—The continuous hot bath is now rarely employed except in burns and cases of phagedena, when it often proves curative. In these cases an antiseptic agent may be dissolved in the water. Continuous immersion in a warm bath is regarded favorably by some surgeons for the treatment of slouging wounds and large purulent areas. The immersion of a part from time to time in water as hot as can be tolerated is useful in fully developed and in chronic inflammation. Such immersion benefits an inflamed joint, lessening the pain, swelling, and stiffness.

Dry heat is applied by a metallic object dipped in hot water and laid upon the part; by Leiter's tubes, through which hot water flows; by the hot-water bag or by the hot-air apparatus. Some surgeons use the hot-water bag in cases of mild appendicitis, in order to favor the formation of adhesions. The hot-water bag is often soothing and beneficial when laid upon an inflamed joint, or on the perineum or the hypogastric region in cystitis. A bag of hot sand, a hot brick, or a bottle or can of hot water can be used instead of the bag. The hot-air apparatus is of very great service in the treatment of inflamed joints.

Treatment when Suppuration is Threatened.—When suppuration is threatened, ordinary hot fomentations or antiseptic fomentations must be used, and the part must be kept at rest. As previously explained, the flaxseed poultice is inadmissible. When suppuration is threatened the use of heat causes the collection of multitudes of leukocytes, which tend to limit the area of infection and destroy bacteria. Even when suppuration is not prevented heat aids in the rapid breaking down of the tissue at the focus of the inflammation and causes hordes of leukocytes to gather and encompass the suppurating tissue, and these leukocytes prevent the spread of the infection.

In most cases, when suppuration is obviously inevitable or seriously threatened, a free incision will be of greatest benefit.

Irritants and Counterirritants in Inflammation.—Irritants attract an increased supply of blood to the part whereon they are applied, and are used for their local effects. *Counterirritants* are used to affect by reflex influence some distant part. In chronic inflammation irritants may do good by promoting the blood-supply, thus favoring the removal of exudates (liniment in rheumatism and synovitis, and nitrate of silver in ulcers). Counterirritants are powerful pain-relievers when used over an inflamed structure; they bring blood to the surface and are thought by many writers to cause anemia of internal parts, the site and area of anemia depending on the site, the area, and the duration of the surface-irritation. Nancrede dissents from the statement that counterirritants cause anemia of internal parts; and he maintains that they irritate deeper parts and cause more external blood to be taken to them. He claims that a blister applied to the chest produces a hyperemic area in the pleura. Nancrede, in his work upon the *Principles of Surgery*, refers to Furneaux Jordan's opinion that direct irritation to the surface over a joint adds to synovial hyperemia, and that consequently in joint-inflammation counterirritants should be applied above and below a joint, but not directly over it. As a matter of fact, we know clinically that powerful counterirritation directly over an inflamed superficial joint is occasionally followed by an aggravation of the trouble, and that in pericarditis blistering directly over the pericardium may, as pointed out by Brunton, make the condition worse. Counterirritants not only relieve pain in the earlier stages of inflammation, but they also promote absorption of exudate in the later stages, and are particularly valuable in chronic inflammations. Great benefit is obtained by blistering old thickened ulcers, and by painting the chest with iodin to relieve pleuritic effusion. Frictions, besides their pressure-effects, act as counterirritants. Frictions may relieve skin-pain, and are associated with the application of stimulating liniments in the treatment of stiff joints. A mustard plaster is a valuable counterirritant in an acute deeply-seated inflammation. Tincture of iodin is extensively used in chronic inflammation.

There is no more efficient method of relieving pleural effusion than by the application of a succession of blisters. Blisters are also used in the treatment of inflamed joints, pericarditis, pneumonic consolidation of the lung, acute and chronic rheumatism, etc.; and are applied back of the ears or at the nape of the neck in congestive coma or meningitis.

A blister can be produced in a few minutes by soaking a bit of lint in chloroform, and after applying it to the surface, covering it with oiled silk, and then with a watch-glass. Equal parts of lard and ammonia will blister in five minutes. It is easier to blister with cantharidal collodion or blistering-paper. Before applying a blister, shave the part if it be hairy; then grease the plaster with olive oil and apply it. Blistering plaster is left in place six hours in the case of an adult, but only two hours in the case of an old person or a child; the plaster is then removed, and if a blister has not formed, the part must be poulticed for a few hours. When a blister is obtained, open it with a needle which has been dipped in boiling water. If the surgeon wishes the blister to heal, it should be covered with a piece of lint smeared with cosmolin or with zinc ointment. If it is to be kept open for a time, cut away the stratum corneum and dress with cosmolin, each ounce of which contains six drops of nitric acid.

Pustulation can be effected with tartar-emetic ointment or with Vienna paste. Tartar-emetic ointment was formerly used on the scalp in meningitis. Vienna paste consists of 5 parts of caustic potash and 6 parts of lime made into a paste with alcohol. It is applied for five minutes, and is then washed off with vinegar.

The hot iron is the most powerful of counterirritants. It is chiefly used in chronic inflammation of joints, bone, and the spinal cord. The application is, of course, very painful, and it is best to give an anesthetic before using the cautery. A flat cautery iron may be used, or the round iron. The latter is known as the button or Corrigan's cautery. The iron is used at a white heat. One area or several may be seared. The cautery is drawn lightly two or three times over each spot we wish to burn. The object is to destroy only the superficial layers of the skin. After the cauterization is completed, lint wet with iced water is applied for several hours to allay pain, and then hot antiseptic fomentations are used until the slough separates.

If we wish to prevent healing after separation of the slough, dress the sore with cosmolin, each ounce of which contains 6 drops of nitric acid. It is not wise to cauterize deeply directly over a superficial joint.

Constitutional Treatment of Inflammation.—Certain remedies are used in inflammation for their general or constitutional effects; these remedies are—(1) general bleeding; (2) arterial sedatives; (3) cathartics; (4) diaphoretics; (5) di-

uretics; (6) anodynes; (7) antipyretics; (8) emetics; (9) mercury and iodids; (10) stimulants; and (11) tonics.

General bleeding, *venesection*, or *phlebotomy*, is suited to the early stages of an acute inflammation in a young and robust subject. The indication for its employment is increased arterial tension, as shown by a strong, full, rapid, and incompressible pulse in a vigorous young patient. General blood-letting diminishes blood-pressure and increases the speed of the blood-current, thus amends stasis, absorbs exudate, and washes adherent corpuscles from the vessel-wall; furthermore, it reduces the whole amount of body-blood and thus forces a greater rapidity of circulation, decreases the amount of fibrin and albumin, lowers the temperature, arrests cell-proliferation, and stops effusion.

This procedure was in former days so highly esteemed that it settled into a routine formula to be applied to every condition from yellow fever to dislocation. The terrible mortality of the cholera epidemics from 1830 to 1835 led practitioners to question the belief that bleeding was a general panacea, and from this doubt there was born in the next generation violent opposition to bloodletting in any disease. Like most reactions, opposition has gone too far, the pendulum of condemnation has swung beyond the line of truth and sense, and thus is universally neglected or broadly condemned a powerful and valuable resource. Many physicians of long experience have never seen a person bled; its performance is not demonstrated in most schools, and but few patients and families will permit it to be done. But when properly used it is occasionally beneficial. It is only applicable, however, to the young, strong, and robust, and not to the old, weak, or feeble. It is used for violent acute inflammations of important organs or tissues, and not for low inflammations or for slight affections of unimportant parts. It is used in the early, but not in the late, stages of an inflammation. It is used when the pulse is frequent, full, hard, and incompressible, but not when it is slow, small, soft, compressible, and irregular. It is used when the face is flushed, but not when it is pallid. It is not used in fat persons, drunkards, very nervous people, or the sufferers from adynamic, septic, or epidemic diseases. It is of value in some few cases of congestion of the lungs, pneumonitis, pleuritis, meningitis, prostatitis, cystitis, and other acute inflammatory conditions. (See Phlebotomy.)

After bleeding, the patient should be put upon arterial sedatives, diuretics, diaphoretics, anodynes, and, if necessary,

purgatives. A favorite mixture of Prof. S. D. Gross was the antimonial and saline, consisting of gr. xl of Epsom salt, gr. $\frac{1}{10}$ of tartar emetic, 2 drops of tincture of aconite, and ʒj of sweet spirits of niter, in enough ginger syrup and water to make ℥ss; given every four hours.

Arterial sedatives are of great use before stasis is pronounced; but if used after stasis is established they will increase it. If stasis exists it may be relieved by blood-letting, local or general, and then arterial sedatives can be given. Either local bleeding or venesection abolishes stasis and lowers tension, and arterial sedatives maintain the effect and hold the ground which is gained. The arterial sedatives employed are aconite, veratum viride, gelsemium, and tartar emetic. These sedatives lessen the force and the frequency of the heart-beats, and thus slow and soften the pulse, and are suited to a robust person with an acute inflammation, but are not suited to a weak individual in an adynamic state.

Aconite is given in small doses, never in large amounts. One drop of the tincture in a little water is given every half hour until its effect is manifest on the pulse, when it may be given every two or three hours. Large doses of aconite produce pronounced depression, and are dangerous. Aconite lowers the temperature, slows the pulse, and produces diaphoresis.

Veratrum viride is a powerful agent to slow the pulse and to lower blood-pressure; it produces moisture of the skin, and often nausea. It is given in 1-drop doses of the tincture every half hour until its physiological effects are manifested, when the period between doses is extended to two or three hours. Ten drops of laudanum given a quarter of an hour before each dose of veratrum viride will prevent nausea.

Gelsemium is an arterial sedative highly approved by Bartholow. It is given in doses of 5 to 10 drops of the tincture every three or four hours.

Tartar emetic lowers arterial tension and lessens the pulse-rate. This drug is not largely employed; if it is used with the greatest care, it is no better than some other agents, and if it is not so used it will cause dangerous depression. The dose is from gr. $\frac{1}{20}$ to gr. $\frac{1}{10}$ in water every three hours until the physiological effects are manifest.

Cathartics.—Purgation is of great value in inflammation. By it putrid material is removed from the intestine, fluid containing poisonous elements is drawn from the blood, and the liability to infection of the tissues is lessened. The administra-

tion of purgatives is, of course, not to be a routine procedure in inflammatory states. The bowels may be acting so freely that no cathartic is required. Treatment in an inflammation should be inaugurated, if constipation exists, by giving a cathartic. The tongue affords important indications as to the necessity for purgation. Castor oil can be given in capsules, or the juice of half a lemon is squeezed into a tumbler, 1 ounce of oil poured in, and the rest of the lemon is squeezed on top, thus making a not unpalatable mixture. Aloïn, podophyllum, the salines, and calomel in 5- or 10-grain doses, followed by a saline, have their advocates. In peritonitis the salines are of unquestionable value, a teaspoonful of Epsom salt and a teaspoonful of Rochelle salt being given hourly until a movement occurs. In the course of inflammation, from time to time, if there be constipation, a coated tongue, and foulness of the breath, there should be ordered gr. j of calomel with gr. xxiv of bicarbonate of sodium, made into twelve powders, one being given every hour; if the bowels are not moved by the time the powders are all taken, a saline should be given. If a violent purgative effect is desired, as in meningitis, croton oil or elaterium may be ordered. If constipation is persistent, give fluid extract of cascara sagrada daily (20 to 40 drops), or a pill at night containing gr. $\frac{1}{4}$ of extract of belladonna, gr. $\frac{1}{4}$ of extract of nux vomica, gr. $\frac{1}{10}$ of aloïn, gr. $\frac{1}{4}$ of extract of physostigma, and gt. $\frac{1}{2}$ of oil of cajuput. Enemas or clysters may be used in some cases. A very useful enema is composed of f℥j of oil of turpentine, f℥iss of olive oil, f℥ss of mucilage of acacia, in f℥x of water. Soapsuds and vinegar in equal parts make a serviceable clyster. A combination of oil of turpentine, castor oil, the yolk of an egg, and water can be used. Asafetida, gr. xxx to the yolk of one egg, makes a good enema to amend flatulence.

Diaphoretics are very useful. A profuse sweat removes much toxic material from the blood and in the beginning of an acute inflammation, such as tonsillitis, may abort the disease. Dover's powder is commonly used, but pilocarpin is preferred by some. Camphor in doses of from 5 to 10 grains is diaphoretic, and so are antimony and ipecac. Acetate and citrate of ammonium, opium, alcohol, hot drinks, heat to the surface (baths, hot bricks, hot-water bags), serpentaria, and guaiac are diaphoretic agents.

Diuretics are useful in fevers when the urine is scanty and high-colored, and are valuable aids in removing serous effusions and other exudates. Among the diuretics may be mentioned calomel in repeated large doses, cocain, caffein,

alcohol, digitalis, the nitrites, squill, turpentine, copaiba, and cantharides. The liquor potassæ and the acetate of potassium are the best agents to increase the solids in the urine. The liquor potassii citratis in doses of f℥j to f℥iv is efficient. Large draughts of water wash out the kidneys. If the heart is weak, citrate of caffein is a good stimulant diuretic.

Anodynes and *hypnotics* may be required. Dover's powder, besides being diaphoretic, is anodyne. Opium acts well after bleeding or purgation. If it causes nausea, it should be preceded one hour by the administration of gr. xxx of bromid of potassium. Opium is used by the mouth, by the rectum, or hypodermatically. It is used when there is pain, but its use is not to be long persisted in if it can be avoided. It is given in doses measured purely by the necessities of the case. If opium disagrees, try the combination of morphin with atropin. After an operation antipyrin or phenacetin will often quiet pain and secure sleep. When a person feels "so tired he can't sleep," alcohol in the form of whiskey or brandy must be given. Sleeplessness not due to pain is met by chloral, trional, the bromids, or sulphonal. Chloral is dangerous in conditions of weak heart or exhaustion. Bromids must be given in large doses to be efficient. Sulphonal must be given about four or five hours before sleep is expected, in doses of from gr. x to gr. xx in hot milk or hot mint-water. Trional is safe and very satisfactory. It is given in doses of gr. xv to gr. xxv in hot water.

Antipyretics.—Diaphoretics, purgatives, and arterial sedatives lower temperature, and have previously been alluded to (p. 96). There are two great classes of febrifuges—those which lessen heat-production and those which increase heat-elimination. In the first group we find quinin, salicylic acid and the salicylates, kairin, alcohol, antimony, aconite, digitalis, cupping, and bleeding. In the second group we find alcohol, nitrous ether, antipyrin, acetanilid, phenacetin, opium, ipecac, cold to the surface, and cold drinks. In surgical inflammations it is rarely necessary to employ heroic means to lower temperature. The use of such an agent as antipyrin is contraindicated in the weak and adynamic, and it is never to be thought of as a means of lowering temperature unless the latter goes above 103° F. Quinin, in doses of gr. xx to gr. xxx given at 4 P. M., may prevent an evening rise; salol or salicin can be given during the day. Inunctions of 30 minims of guaiacol lower the temperature in tubercular conditions and in septic fevers. These inunctions are made upon the abdomen, and often produce surprising results.

Dujardin-Beaumetz maintained that fever is a condition in which the organism is endeavoring to oxidize and render inert certain poisonous material, and that antipyretic drugs lessen oxidation and actually make the patient worse. This view is in accordance with the experience of a number of surgeons. It is a suggestive fact that bacteria are said to multiply more rapidly when kept at about the normal body temperature than when kept at fever heat (102° F., or more). The mere discomfort of fever may be much mitigated by antipyretic drugs, but the fever-process is not benefited by them.

Emetics.—Emetics may do good when the patient suffers from a parched, coated tongue, a dry and hot skin, nausea, and gastric oppression, but it is very rarely in these days that we employ them. There can be used ʒj of alum in molasses, gr. xx of sulphate of zinc, or a tablespoonful of mustard and a teaspoonful of salt given in warm water and followed by large draughts of warm water. Ipecac in a dose of gr. xx can be employed. The emetic dose of tartar emetic is gr. ij, but it is too depressant a drug to trifle with. The sulphuret of antimony in doses of from 1 to 5 grains is safe. Apomorphin hypodermatically, in a dose of from gr. $\frac{1}{16}$ to gr. $\frac{1}{8}$, will act in five minutes. Emetics are valuable in inflammatory conditions of the air-passages, but their use is contraindicated in diseases of the heart, brain, and bowels, in hernia, in dislocations, in fractures, and in aneurysms.

Mercury and the Iodids.—Mercury is an alterative—that is, an agent which favorably affects body-nutrition without causing any recognizable change in the fluids or the solids of the body. Mercury lessens blood-plasticity, hinders the exudation of liquor sanguinis—thus furnishing less food to the cells in the perivascular tissues—and retards cell-proliferation. Further, by a stimulant action on the absorbents it promotes the breaking up of an existing inflammatory exudation, and hence limits damage from excess of new formation. The time at which mercury is best given is when violent symptoms have abated, the guides being a reduced temperature and a moist skin. Mercury is often given in conjunction with the local use of sorbefacients (ichthyol, or mercurial ointment, when possible, is associated with compression of the inflamed part.) It is sometimes given until the gums are slightly touched, but it is not given to the point of salivation. When the breath becomes offensive and the gums tender on snapping the teeth, or when griping and diarrhea begin, the dose should be reduced, or the drug

should be stopped (see Ptyalism). In iritis mercury is used to get rid of the plastic effusion which is causing pupillary fixation and opacity. In keratitis the gums should be touched *lightly*. In orchitis, after the subsidence of the acute symptoms, mercury should be employed. In pericarditis, meningitis, and in many chronic and lingering, and in all syphilitic inflammations, this drug can be used.

Some persons will be salivated with very minute doses of mercury, either because of idiosyncrasy or previous saturation. Others can take enormous doses without any appreciable constitutional effect. The action of mercurials can be favored by a combination with ipecac or with tartar emetic.

In giving mercury, if a prompt effect is desired, give gr. iij of calomel every three hours until a metallic taste is noted in the mouth. If the case is not so urgent, gray powder is a good combination. Children are given calomel and sugar or mercury and chalk. If it is desired to give the drug for some time, corrosive sublimate is a suitable form, and small doses will actually increase the number of red blood-corpuscles. Corrosive sublimate is to be given alone or combined only with iodid of potassium. The green iodid of mercury is a drug suitable for prolonged administration. In the prolonged use of mercury it will often be necessary to give at the same time a little opium to prevent diarrhea and griping. A rapid effect can be obtained by rubbing daily with a gloved hand ʒj of the oleate of mercury or ʒss of the ointment into the groins, the axillæ, or the inside of the thighs. Suppositories of mercurial ointment induce rapid ptyalism. Hypodermatic injections of corrosive sublimate or gray oil may be used, and must be thrown deeply into the muscles of the buttock or back. Old people, those who are exhausted, anemic, and broken down, and the tubercular bear mercury badly. If it be given to them at all, it must only be in small amounts and for a brief time.

Alkaline iodids are useful in removing the products of inflammation; they can be given for a long time, and admirably supplement mercurials. Iodid of potassium can be prescribed in combination with corrosive sublimate as follows:

℞. Hydrarg. chlor. corros.,	gr. ij;
Potass. iodidi,	ʒv et ℈j;
Syr. sarsaparillæ comp.,	q. s. ad f ʒviij.—M.

Sig. fʒij, in water, after meals.

Iodid of potassium, well diluted, is given on a full stomach; it is never given concentrated or before meals. A

convenient mode of administration is to procure a concentrated solution of the iodid of potassium, remembering that every drop equals gr. j of the drug, and give as many drops as may be desired in half a glass of water after meals. If the medicine disagrees, add to each dose, after it is put in water, ʒj of the aromatic spirit of ammonia. Extract of licorice is a good vehicle for the iodid. If the mixture in water disagrees, the drug should be given in milk. Capsules are satisfactory, but a drink of water should be taken just before and again just after taking a capsule, to protect the stomach from the concentrated drug. Iodid of sodium may agree when iodid of potassium does not. When the iodids disagree they produce iodism. The first indications of iodism are a bad taste in the mouth, running of the eyes and nose, and sneezing, followed by a feeling of exhaustion, absolute loss of appetite, nausea, tremor, and skin-eruptions (acne, hemorrhages, blebs, hydroa, etc). If iodism occurs, stop the drug and give the patient Fowler's solution in increasing doses, laxatives, diuretic waters, and also nutritious food, and stimulants if depression is great. Sometimes belladonna does good in obstinate cutaneous disorders induced by the iodids.

Remedies Directed Against Special Morbid States.—If inflammation is associated with rheumatism, gout, scurvy, syphilis, tuberculosis, or any other constitutional disease or predisposition, appropriate treatment should be instituted to control the disease or combat the predisposition, and at the same time the area of inflammation must be locally treated. Syphilis is treated by the internal use of mercury. and in some cases the iodids are also given; scurvy, by vegetable juices and potash salts; rheumatism, by the alkalies or salicylates; gout, by colchicum or piperazin; tuberculosis, by the fats, tonics, and an open-air life.

The use of *alcoholic stimulants* is called for by conditions rather than by diseases, being indicated by the state of the patient rather than by the name of the malady. For a brief acute inflammation in a robust young person alcohol is not needed; but all who are weak or exhausted, be they young or old, all who are aged, those who are accustomed to alcoholic beverages, those who have high temperatures or failure of circulation, and those who labor under septic inflammations or adynamic processes—require alcohol, and it should be given with a free hand. In an acute malady, a feeble, compressible, rapid, or irregular pulse, and great weakness of the first sound of the heart are indications that alcohol is

required. Low, muttering delirium is a strong indication for stimulation. There is no *dose* of alcohol for these states; it is given for its effect. Two ounces of brandy or whiskey may be needed in a day, or perhaps twenty ounces. If the breath of the patient smells strongly of the alcohol, he is getting too much. If delirium increases after each dose, alcohol is doing harm. Alcohol is contraindicated in acute meningitis. In acute illness use whiskey, brandy, champagne, or alcohol and water. During convalescence there may be used a little spirit, port, claret, or sherry wine, or malt liquor. These agents will promote appetite, digestion, and sleep.

Strychnin is a very valuable stimulant. It can be given in doses of gr. $\frac{1}{30}$ to gr. $\frac{1}{20}$ three times a day.

Tonics are indicated during convalescence from acute and throughout the course of chronic inflammations. There may be used iron, quinin, and strychnin in the form of elixir; iron alone, as in the tincture of the chlorid; quinin in tonic doses (gr. vj to gr. viij daily); or Fowler's solution of arsenic. An excellent pill consists of—

℞. Acid, arsenos.,	gr. j;
Strychnini,	gr. ss;
Quinini,	gr. xlviij;
Ferri redact.,	gr. vj.—M.
Ft. in pil. No. xxiv.	
Sig. One after each meal.	

Bitter tonics before meals improve the appetite. One of the best of tonics is tincture of nux vomica in gradually increasing doses.

Antiphlogistic regimen is a term comprising the necessary directions relating to diet, ventilation, cleanliness, etc.

Diet.—When, in the early stages of an acute inflammation, the patient cannot eat, there must be administered a cathartic before food is given. Nausea is combated with calomel and soda, drop-doses of a 6 per cent. solution of cocain, iced champagne, iced brandy, chloroform-water, hot water, cracked ice, or the application of counterirritation to the epigastric region. When the process is depressive from the start, and in any case after the earliest stage, feeding is of vital moment. The great tissue-waste calls for large quantities of nutritive material, but the impaired digestion demands that the food shall be easily assimilable; hence it is taken in liquid form, small quantities being frequently given. Milk contains all the elements required by the body, and is the food of foods. If it disagrees, it should be boiled and mixed with lime-water, or to each dose an equal amount of Vichy or soda-water may

be added. Peptonized milk is a valuable agent. One part of milk, 2 parts of cream, and 2 parts of lime-water make a nutritious and digestible mixture. Milk punch is largely used. Whey may be used when plain milk cannot be taken. Eggs are highly nutritious, but are apt to disturb the stomach; they may be given as egg-nog, or simply soft-boiled, or the yolk can be beaten up in a cup of tea. When considerable nausea exists the yolk of an egg may be added to ℥j of lemon-juice and ʒij of sugar, the glass being filled with carbonated water. Beef tea is certainly a stimulant, but its food-powers are questionable. It is prepared by cutting up one pound of lean beef, adding to it a quart of water, and then simmering, but not boiling, down to a pint, finally filtering and skimming the liquid. The dose is a wineglassful seasoned to taste. Meat-juice, obtained by squeezing partly cooked meat with a lemon-squeezer, is extremely nutritious. Liquid-beef peptonoids are both agreeable and nutritious; they are given in doses of ℥ss to ℥j. Clam-juice is palatable and digestible. When nothing else will stay on the stomach koumiss will often be retained. This fermented milk is nutritious, stimulant, and very useful. Coffee is a valuable stimulant in febrile conditions. If the stomach retains no food, the patient must be fed entirely by the rectum. If the stomach rejects most of the food swallowed, mouth-feeding must be supplemented by nutritive rectal enemata. When the sufferer feels able to eat a little, any good soup, strained and skimmed, should be ordered. As the patient gets better he may be fed on sweetbreads, chops, oysters, etc., until he gradually reaches ordinary diet.

The *temperature* should be taken at regular intervals, and the condition of the gastro-intestinal tract should be observed. The *urine* must be examined at intervals, and the daily amount passed must be known. If insufficient urine is being passed, increase the amount of fluid, particularly of water, given by the mouth. If the urine is scanty and the patient is nauseated by drinking water, give enemata of hot saline fluid or employ hypodermoclysis. The *pulse* and *heart* must be frequently observed, and cardiac weakness must be combated by suitable stimulants.

Ventilation and Cleanliness.—The ventilation of the apartment is of the greatest importance. Every day the windows should be opened widely for a time, the patient, of course, being protected. When the windows are open the air of a room can be quickly changed by swinging the door to and fro. A constant access of fresh air must be secured, and

the temperature kept as near as possible to 68° F. The sick man must be cleaned and be sponged off with alcohol and water every day if high fever exists. It is important that the bed-clothing be clean and that the sheet be unwrinkled, as otherwise bed-sores may form.

IV. REPAIR.

When a tissue is damaged, it reacts to the injury and Nature attempts to effect repair. It is held by many that inflammation is a destructive process and repair is a constructive process; that repair is constantly effected in an aseptic wound without many of the evidences of inflammation; that repair does not proceed from inflammation, but is retarded or prevented if inflammation occurs. As before stated, we agree with Adami, that inflammation is reaction to injury and the effort of Nature to repair the injury. As Adami points out, the attempt to repair may fail, the reaction to injury being excessive or not powerful enough; but even should the attempt fail the conservative intention exists. "What is the development of cicatricial tissue but an attempt at repair? What other meaning can be ascribed to the increased bactericidal power of the inflammatory exudate as compared with that of ordinary lymph and blood-serum? Why do leukocytes accumulate in a region of injury? Why do some of them incorporate bacteria and irritant particles, and others bring about the destruction of these without necessarily ingesting them? All these are means whereby irritants are antagonized or removed, and reparation and return to the normal sought after."[1]

Healing by First Intention.—A wound may heal by "first intention." This mode of healing, which is known as "primary union," occurs without suppuration, and is observed in the healing of an aseptic wound. If infection occurs, primary union will not take place. The phrase "by first intention" comes down to us from the past. It was properly thought that Nature intends to repair a wound, and first intention signifies the first or most desirable way to be wished for. In a small aseptic incision, in which no considerable vessels are cut, repair will take place very rapidly after the edges have been approximated and the wound dressed. In fact, the wound-edges may be firmly held together in twenty-four hours. In such a wound a small amount of blood flows from the capillaries between the

[1] Adami, in Allbutt's *System of Medicine.*

edges of the wound, and this blood clots. A trivial amount of exudation and some few migrated corpuscles pass into the clot and into the tissues. The fixed connective-tissue cells and the endothelial cells of the vessels multiply, and form epithelioid cells, known as fibroblasts. The fibroblasts multiply, so that the new cells from one side of the wound finally interlace with the new cells from the other side. These fibroblasts eat up many of the leukocytes. Near-by capillaries become irregular in outline; at certain points bulging occurs, and at these points new capillaries develop, extend into the mass of fibroblasts, and join new capillaries of the opposite side. The reparative material is now said to be organized; it has become granulation-tissue. The fibroblasts become spindle-shaped and develop into interlacing fibers (Fig. 31). The tissue is now fibrous tissue; it contracts strongly, and finally most of the capillaries are obliterated by pressure. In such a slight wound the reaction to injury is chiefly noted in the cells of the part, and the vessels and leukocytes play but a small part in repair. The exudation is so scanty that there is practically no swelling unless some arises from venous obstruction. The vessels are so slightly affected that there is no redness. The final step in healing is contraction of the fibrous tissue and the covering of the surface with epithelium, which springs from the epithelial cells upon the edges. This final process is called "cicatrization," and consists in contraction of the wound and skimming over with epithelium. The "immediate union" of some writers never occurs. This term means the union of microscopical parts to their counterparts without any effort at repair. A first union is effected always by clotted blood and coagulated exudate, next by proliferating cells, and finally by fibrous tissue. A wound healing by first intention exhibits no evidence of inflammation. There is some slight tenderness, but no actual pain. A certain amount of swelling arises because of exudation of fluid from the blood, and the coagulation of this fluid makes the wound-edges hard. Venous obstruction leads in some cases to a considerable fluid swelling. In a more extensive incised wound many vessels are cut. After oozing ceases the vessels are closed by clots continuous with the clot between the sides of the wound. An

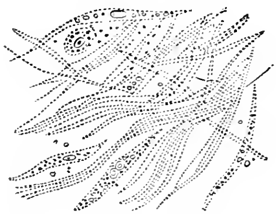


FIG. 31.—Cells developing into fibers (Bennett).

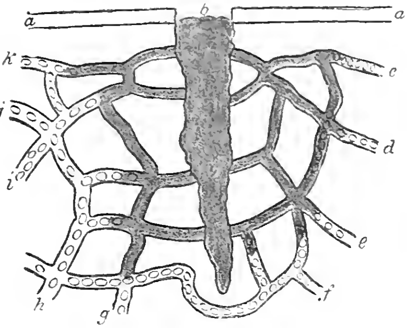


FIG. 32.

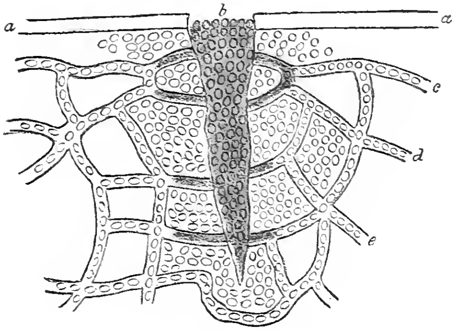


FIG. 33.

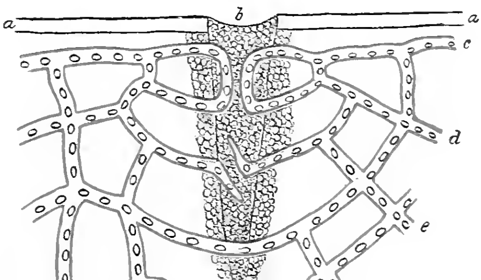


FIG. 34.

FIGS. 32–34.—Healing by first intention (after Pick): *a*, skin; *b*, fibroblasts; *c*, *d*, *e*, capillaries. FIG. 32. Clot in the vessels continuous with clot between the edges of the wound. FIG. 33. Migration of leukocytes into the perivascular tissues and into the clot between the edges of the wound. FIG. 34. Formation of new capillaries.

exudation of plasma from the vessels and of lymph from the lymph-spaces takes place. Leukocytes in great num-

bers invade the wound-edges and the exudate, and the exudate clots. This mass of blood-clot, plasma-clot, and leukocytes used to be known as "coagulable lymph." The leukocytes actively eat up the clot, and by the end of the third day occupy the space formerly occupied by the clot. The fixed connective-tissue cells and endothelial cells multiply, and grow into the mass of leukocytes, eating up many of the leukocytes, and finally join the fibroblasts of the other side of the wound. Some leukocytes proliferate, others get back into the lymph-spaces. New capillaries form from the capillaries at the wound-margins. By the end of the first week the fibroblasts begin to assume various outlines, sending out poles or branches or becoming spindle-shaped. These spindle-shaped cells become fibers, and the fibers of the new tissue interlace and strongly contract. Thus the edges are pulled firmly together. Finally new epithelium derived from epithelium at the edges forms and grows over the wound (Figs. 32–34), and exhibits the stages of repair in healing by first intention. During the first twenty-four hours after a large wound begins to heal by first intention the discharge of bloody serum is most plentiful, but after this period it becomes very scanty and soon ceases entirely, and can be much diminished in quantity in the first day by the application of pressure. Warren says that after a hip-joint amputation over a pint of bloody serum flows out during the first twenty-four hours. In a large wound special methods to secure drainage are required. In a small wound drainage is obtained between the stitches. The use of irritant germicides in a wound greatly increases the amount of discharge and renders drainage necessary in even a comparatively small wound for the first twenty-four hours. In an aseptic wound, as a rule, one-half of the stitches are removed on the fifth or sixth day and the remainder on the eighth day, but for two weeks more the wound should be rested and supported, as the new tissue is not very resistant to infection. Aseptic fever always arises when much exudation is given out and not quickly and perfectly drained. Aseptic fever is due to the absorption of aseptic pyrogenous material (p. 115). If an incised wound becomes infected, the pyogenic organisms destroy the bond of union which is forming between the wound-edges by liquefying the intercellular substance. As a consequence the wound-edges are widely separated by pus.

What used to be known as "healing by blood-clot" is healing by first intention. If there is a considerable gap

between the edges of an aseptic wound, and the gap is filled with a blood-clot, healing goes on in the same manner as when the gap is narrow, although more corpuscles, more exudate, and more fibroblasts are required to effect repair.

Healing by Second Intention.—Healing of a wound in which there is a large cavity in the tissue or in which the edges have gaped apart is known as healing by granulation or healing by "second intention." It is effected in the same manner as healing by "first intention," the processes in the two cases being practically identical. As a matter of fact, in healing by granulation there is usually wound-infection. As a result of infection intercellular substance is peptonized, many reparative cells are cast off, and repair can be effected only after the formation of enormous numbers of fibroblasts and the expenditure of considerable time. It requires much longer for an infected wound to heal than for an incised wound to be repaired, and an infected wound can heal

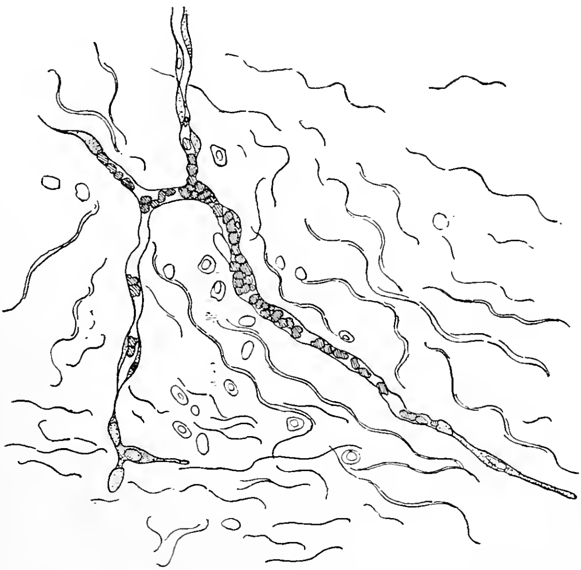


FIG. 35.—Development of a blood-vessel in mesentery of an embryo (Warren).

only by granulation. After the infliction of a wound the oozing ceases because thrombi form in the vessels and some clot gathers in tissue-gaps and interstices. Exudation begins and leukocytes migrate into the exudate and into the walls of the wound. In an hour or two the surface of the wound

becomes distinctly glazed or glistening, because of the formation and coagulation of fibrin. The exudation is at first thin and red, and it becomes so profuse as to wash away the discolored fibrin coat. In a few days the discharge usually becomes purulent. The connective-tissue cells proliferate and form fibroblasts, and the fibroblasts multiply to close the wound. From adjacent capillaries new capillaries form.

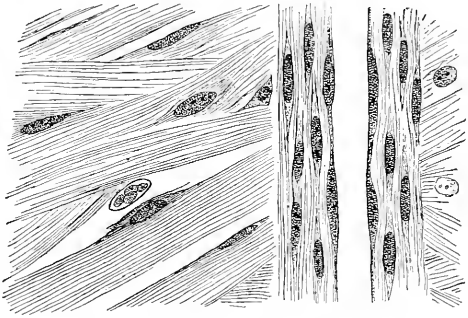


Fig. 36.—Cicatricial tissue; × 670 (Fowler).

This formation takes place as follows: A portion of a capillary thickens and a whip-like process comes off from the the thickened part. This process fuses with a second filament budded from another or from the same capillary, or runs straight out as a terminal vessel. The filaments after a time are hollowed out from within, protoplasmic tubes are formed,

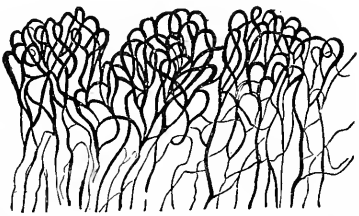


Fig. 37.—Blood-vessels in granulation (Gross).

and endothelial cells develop from the protoplasm. In some cases a tubular prolongation comes off from a capillary directly. Fig. 35 shows the formation of a capillary. In a wound healing by granulation these newly formed capillaries run among the fibroblasts, and some of them run perpendicularly to the surface, or a loop forms and reaches the surface. The surface of a granulating wound is covered with migrated

leukocytes, and directly under these are the new vascular strings or loops. Vascular strings or loops covered with white corpuscles are called granulations (Fig. 37 shows a granulating surface). When the discharge becomes purulent, many leukocytes and fibroblasts are destroyed, inflammation increases, exudation becomes profuse, and cellular multiplication widespread and rapid in order to make up for the cells lost by microbic action. Gradually the gap is filled. As it is being filled the older fibroblasts in the deeper layers of the edges and base of the wound are converted into cicatricial, fibrous, or scar tissue. As the granulations rise to a higher level at the surface the area of fibrous tissue becomes broader at the base and margins, and this young fibrous tissue contracts. By contracting it draws the edges of the wound nearer together and thus lessens the area of the surface which must be covered with epithelium. When the granulations reach the level of the cutaneous surface the epithelial cells at the margin of the wound proliferate, and young epithelial cells, constituting a bluish or opalescent film, grow over the granulations. Epithelium comes only from epithelium. Granulations are never converted into epithelium. The epithelial covering comes only from the epithelium at the wound-margins, unless there be epithelial remains in the wound; for instance, an undestroyed papilla, sweat-duct, or hair-follicle. The process of covering the surface with epithelium is known as epidermization. Before, during, and for a time after epidermization the fibrous tissue of the walls and base of the wound contracts. Thus the wound-margins are pulled and held nearer together, the gap to be bridged is diminished in size, the danger of tearing apart of the epithelial coat is lessened, many capillaries are destroyed by pressure, and the scar becomes firm, white, and puckered. Cicatrization consists in the covering of the granulations with epithelium and also in the contraction of the new fibrous tissue. If infection is severe, destruction will exceed repair and healing will not occur. In such a case there is coagulation-necrosis of granulation-tissue, and the wound becomes covered with tissue-remains (aplastic lymph). If granulations rise above the cutaneous level, healing will not take place, because the epithelium cannot grow over the surface. A wound in this condition is said to possess exuberant granulations, or "proud flesh." In some cases the granulations are pale from insufficient blood-supply, and in others edematous from venous congestion. Contraction of the fibrous tissue may be insufficient because

there is adhesion to deep unyielding fascia or to periosteum. Excessive contraction, so often seen after burns, often produces terrible deformity. The scars or cicatrices of burns contain much elastic tissue. Infected wounds and ulcers heal by second intention.

Healing by Third Intention.—This consists in the union of two granulating surfaces, the granulations of one side fusing with the granulations of the other side. It is seen in the union of collapsed abscess-walls. The surgeon occasionally seeks to obtain union by third intention by approximating two granulating surfaces. If the surfaces are aseptic, he will often succeed. The process is known as "secondary suturing." It is not unusual to pack a wound with iodoform gauze to control oozing. When this is done it is customary to pass the sutures, but not to tie them. After a few days the gauze is removed and the sutures are tied. This plan renders healing much more rapid than could be obtained by the process of second intention.

Healing of Subcutaneous Wounds.—Blood fills the tissue-gap and the blood clots. Plasma exudes and corpuscles migrate into the clot and the tissue about it. The clot is eaten up by the leukocytes. The connective-tissue cells and the endothelial cells of the adjacent tissue proliferate and form fibroblasts, and fibroblasts multiply and replace the clot. The area of fibroblasts is vascularized by the formation of new capillaries, and fibrous tissue forms and strongly contracts.

Healing of Wounds in Non-vascular Tissues.—In a trivial wound of the cornea a few leukocytes gather from the lymph-spaces and a few of the fixed cells proliferate. In a more severe wound the episcleral vessels dilate, plasma and corpuscles pass into the corneal lymph-spaces, and repair is effected as in vascular tissue.

Repair in cartilage takes place as in the cornea. In both structures any marked injury is repaired by fibrous tissue, and the scar is permanent.

Cell-division.—The multiplication of connective-tissue cells in repair may be by direct, but is usually by indirect, cell-division. *Direct cell-division* consists in division of the nucleus followed by division of the entire cell.

Indirect cell-division, or *karyokinesis*, takes place after remarkable changes in the nucleus. The membrane of the nucleus disappears; the nuclear network becomes first close and then more open; and the cells become round, if not so before. The network of the nucleus, now consisting of one

long fiber, takes the shape of a rosette; next it takes a star-form—the aster stage; two sets of V's next form—the equatorial stage; an equatorial line appears and widens, and each set of V's retreats toward a pole. Thus two new nuclei are formed, each polar V passing in inverse order through the previous changes of shape, and the protoplasm of the original cell collecting about each nucleus (Fig. 38).

Repair of Nerve.—Divided nerve, when the ends are approximated, can regenerate. The ends become united by new connective tissue; this new tissue is a bridge for nerve-cells, and nerve gradually forms in it by the growth of cells from both the central and distal ends, the cells finally meet-

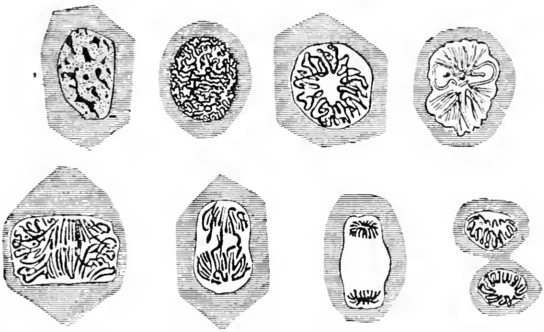


FIG. 38.—Forms assumed by a nucleus dividing (Green, from Flemming).

ing. The fibrous tissue is not converted into nervous tissue. If the ends are not approximated, they join by fibrous tissue, the distal end atrophies, the proximal end becomes bulbous, and nerve-cells do not grow into the fibrous tissue or join the ends of the nerve. The above view is entertained by Mayer and Eichhorst. Waller holds that repair is effected by the central end alone. If a nerve has been divided, it should be sutured.

Repair of Muscle.—When a muscle is divided, the ends retract and a considerable space is left between them. Blood flows into the space between the ends and also between individual fibers of the injured muscle, and the blood clots. Exudation of plasma occurs and migration of corpuscles takes place. Fibroblasts are formed, granulation-tissue is formed by vascularization of the mass of fibroblasts, and granulation-tissue is converted into scar-tissue, but not into muscle. After slight injuries muscular regeneration does occur to some slight extent, either from the

multiplication of living muscle-cells or by metamorphosis of fibrous tissue. If a muscle has been divided, it should be sutured. This process insures more rapid repair and secures a better functional result, and is probably followed by some muscular regeneration.

Repair of Tendon.—When a tendon is divided the ends retract, and the sheath, as a rule, becomes filled with blood-clot. The blood-clot is rapidly removed, fibroblasts replacing it. This new tissue arises from the sheath, and the cut ends do not participate in the process. Granulation-tissue is formed; this is converted into fibrous tissue, and after a time the fibrous tissue becomes true tendon. If no blood-clot forms in the sheath, the walls of this structure collapse and adhere, and the separated tendon-ends are held together by a flat fibrous band formed from the collapsed sheath (Warren's *Surgical Pathology*).

Repair of Bone.—When a bone is broken, a large blood-clot forms in the medullary canal, between the broken ends, below and outside of the periosteum. Masses of new cells are formed. Granulation-tissue replaces the blood-clot as the clot is removed by leukocytes. Granulation-tissue becomes fibrous tissue, and the fibrous tissue in many places becomes cartilaginous. In the second week lime-salts begin to deposit and bone forms.

Repair of Blood-vessels.—If an artery is cut across and ligated, a clot forms within its lumen and about its divided end. The internal clot reaches up to the first collateral branch. Exudation of plasma and migration of corpuscles take place from the vasa vasorum. The clot becomes filled with leukocytes, which gradually destroy it. Fibroblasts form, the clot is replaced by granulation-tissue, granulation-tissue by fibrous tissue, the fibrous tissue contracts, and the artery is converted into a fibrous cord. A divided vein heals in the same manner, except that the internal clot may not reach the first collateral branch or may extend far above it.

Repair of Skin.—The fibrous structure is repaired by fibrous tissue. Hair-follicles, sweat-glands, and sebaceous glands are not reformed. The epithelial layer is regenerated by the proliferation of adjacent epithelial cells.

V. SURGICAL FEVERS.

The surgeon encounters fever as a result of an inflammation or an aseptic wound, in consequence of infection, and in certain maladies of the nervous system. It is important to remember that, while elevated temperature is generally taken as a gauge of the intensity of fever, it is not a certain index. There may be fever with subnormal temperature (as in the collapse of typhoid or pneumonia), and there may be elevated temperature without true fever (as in certain diseases of the nervous system). It is true, however, that elevation of temperature is almost always noted, and is usually accepted as the measure of the height of fever.

The essential phenomena of fever, according to Maclagan, are—(1) wasting of nitrogenous tissue; (2) increased consumption of water; (3) increased elimination of urea; (4) increased rapidity of circulation; and (5) preternatural heat.

Traumatic fevers follow a traumatism and attend the healing or infection of a wound. The forms are—(1) benign traumatic fever; (2) malignant traumatic fever.

Benign traumatic fever is divided into two classes—the aseptic and the septic. There is but one form of aseptic fever, the post-operation rise. The septic benign fevers are surgical fever and suppurative fever. The malignant traumatic fevers are sapremia, septic infection, and pyemia. In this section we discuss only the benign fevers.

Aseptic fever often, but not always, appears after a thoroughly aseptic operation and after a simple fracture or a contusion. It is not preceded by a chill, by chilliness, or by a feeling of illness. It may appear during the evening of the day of operation or not until the next day, and reaches its highest point by the evening of the second day (100° to 103° F.). This elevation is spoken of as the "post-operation rise." Besides the fever there are no obvious symptoms; the patient feels well, sleeps well, and often wants to sit up; there are no rigors and there is no delirium. The wound is free from pain and appears entirely normal. Blood examination shows leukocytosis. This fever is due to absorption of pyrogenous material from the wound-area, the material being obtained from clot or inflammatory exudate, or from both. Many observers believe that the pyrogenous element is fibrin-ferment, which is absorbed from disintegrating blood-clot and coagulating exudate. Warren thinks the fever is due to fibrin-ferment, and "also to other substances slightly

altered from their original composition during life." Some have asserted that the fever is due to nervous shock.

Schnitzler and Ewald have recently studied aseptic fever.[1] These observers maintain that aseptic fever can exist when no fibrin-ferment is free in the blood, that fibrin-ferment can be free in the blood when there is no fever, and, in consequence, that fibrin-ferment is not the cause of the elevation of temperature. They rule out of consideration nervous shock as a cause, and assert that a combination of several factors is responsible, nucleins and albumoses which are set free by traumatism being looked upon as the most active causative agents. The presence of nuclein in the blood in aseptic fever is indicated by leukocytosis and by the increase of the alloxur bodies (including uric acid) in the urine. The capacity of nucleins and albumoses to cause fever is greater in the tubercular than in the non-tubercular. The diagnosis of aseptic traumatic fever is only made after a careful examination has assured the surgeon there is no obscure or hidden area of infection.

In some cases aseptic fever may appear after an operation, and later be replaced by a septic fever. If the temperature remains high after a few days, if other symptoms appear, or if after the temperature becomes normal it again rises, the wound should be examined at once, as trouble almost certainly exists.

Traumatic or surgical fever is seen as a result of infected wounds where there is decided inflammation, but no pus. The real cause is the presence of fermentative bacteria in the wound and the absorption of their toxic products. The most active and commonly present organisms are those of putrefaction. Surgical fever ceases as soon as free discharge occurs, and the appearance of such a fever is an indication for instant drainage. The condition is ushered in two or three days after the operation by chilly sensations and general discomfort. The temperature rises pretty sharply, ascends with evening exacerbations and morning remissions, and reaches its height about the third or fourth day, when suppuration sets in; the temperature begins to drop when pus forms, if the pus has free exit, and reaches normal at the end of a week (see Suppurative Fever). The temperature may reach 104° F. or more, but rarely rises above 103° F. The patient has the general phenomena of fever: Thirst, anorexia, nausea, dry and coated tongue, constipation, pain in the back and legs, and headache.

[1] See *Archiv für klinische Medicin*, Bd. liii., H. 3, 1896; also statement of their views in *Medical Record*, Dec. 19, 1896.

The urine is scanty and high colored. Blood examination shows leukocytosis. The wound is painful, tender, swollen, discolored, and often foul, and stitch-abscesses may form. Some or all of the stitches must be cut, and the area should be asepticized, and packed with iodoform gauze or drained by a tube. The fact that this fever is apt to cease when suppuration begins led the older surgeons to hope for pus and to endeavor to cause it to form. A severe grade of surgical fever, such as arises when there is putrefaction in a large and ill-drained wound, is known as sapremia (p. 174).

Suppurative Fever.—This fever, which is due to the absorption of the toxins of pyogenic organisms, occurs after suppuration has begun, is found when the pus has not free exit, and is an intoxication rather than an infection. It can follow or be associated with surgical fever, or may arise in cases in which surgical fever has not existed. Suppuration in a wound is indicated by a rapid rise of temperature—possibly by a chill. The fever rises to a considerable height, it shows morning remissions and evening exacerbations, and as the temperature begins to fall toward morning sweating occurs. The patient is much exhausted and presents the phenomena of fever previously described. The skin about the wound becomes swollen, dusky in color, and edematous, pain becomes pulsatile, and much tenderness develops. Blood examination shows leukocytosis. The wound must at once be drained and asepticized. In a chronic suppuration, such as occurs in the mixed infection of a tubercular area, there exists a fever with marked morning remissions and vesperal exacerbations, attended with drenching night-sweats, emaciation, diarrhea, and exhaustion. This is known as "hectic fever;" it is really a chronic suppurative fever. The treatment of hectic fever consists in the drainage and disinfection, if possible, the excision of the infected area, the employment of a nutritious diet, stimulants, tonics, remedies for the exhausting sweats, and free access of fresh air.

Other Forms of Fever.—Fever of Tension.—When there is great tension upon the stitches the spots where the stitches perforate ulcerate and some fever arises. To relieve the fever of tension cut one or several stitches. This fever is in some cases surgical, and in some suppurative, according as to whether the infective organisms cause fermentation or suppuration.

Fever of Iodoform Absorption (see p. 29).

Malaria.—It is wise to examine the blood in supposed septic fevers, for only by this means can malaria be excluded.

It is more common to mistake sepsis for malaria than malaria for sepsis.

Surgical Scarlet Fever.—It is maintained by some writers (notably Victor Horsley and Sir James Paget) that a child is rendered especially susceptible to scarlet fever by the shock of a surgical operation. Scarlet fever which develops after an operation is spoken of as surgical scarlet fever. Warren quotes Thomas Smith as having had ten cases of scarlet fever in forty-three operations for lithotomy in children. The puerperal state is supposed also to predispose to scarlet fever. Some surgeons hold that an attack of scarlet fever after an operation is a mere coincidence. Others maintain, and with great show of reason, that a red scarlatiniform eruption appearing after an operation rarely indicates genuine scarlet fever, but usually points to infection, as such eruptions are known occasionally to arise in septicemia.

Hoffa has discussed this subject elaborately. He concludes that four types of eruption can follow operation: (1) a vaso-motor disturbance due to irritation of sensory nerves, and manifested by a transient urticaria or erythema; (2) a toxic erythema due to absorption of aseptic pyrogenous material from the injured area—the absorption of carbolic acid, iodoform, or corrosive sublimate, or the effect of ether; (3) an infectious rash which is sometimes found in septicemia or pyemia, and due to minute emboli composed of bacteria, which emboli lodge in the capillaries; (4) true scarlet fever, with the usual symptoms and complications, the organisms having entered by way of the wound, and the eruption often beginning at the wound-edges (quoted in Warren's *Surgical Pathology*).

Urinary Fever and Urethral Fever (see p. 1016).

VI. SUPPURATION AND ABSCESS.

Suppuration is a process in which tissues and inflammatory exudates are liquefied by the action of pyogenic organisms, and it is a common result of microbic inflammation. The organisms which are responsible are referred to on page 39. Staphylococci produce local suppuration; streptococci cause spreading suppuration. Pyogenic bacteria liquefy exudate by peptonizing it. The pyogenic organisms are very irritant, and when deposited cause inflammation; inflammation leads to exudation, but the exudate cannot coagulate or coagulates but imperfectly, because it is peptonized by the ferment of the micro-organisms. If an area of

embryonic tissue is invaded by the pyogenic micro-organisms, it is promptly peptonized. The peptonizing action is upon the fibrinous elements of an exudate and upon the intercellular substance of embryonic or granulation-tissue. Cells are separated from intercellular substance, and in consequence degenerate and die. Peptonized exudate or embryonic tissue is called pus. In suppurations induced by staphylococci a barrier of leukocytes is first formed around the region of irritation, this barrier is reinforced by fibroblasts, and the pus is imprisoned and kept from spreading. In inflammations induced by streptococci the peptonizing action of the organisms is so great that no barrier of white blood-cells or of proliferating connective-tissue cells forms in time to imprison the micro-organisms; hence the suppuration spreads widely. Suppuration can be induced by the injection of pyogenic bacteria, by their entry through a wound, and by rubbing them upon the skin. In some rare instances, especially when the diet has been putrid, they may enter through the blood and lodge at a point of least resistance. When a medullary canal suppurates after a chill to the surface or after a blow that does not cause a wound, we know that the organisms must have arrived by means of the blood. Organisms which reach a point of least resistance through the blood come from some atrium of infection which may be discoverable or which may not be found. The entry of pyogenic bacteria does not necessarily cause suppuration, as the healthy human body can destroy a considerable number, even if given in one "dose;" but a large number in a healthy, or even a small number in an unhealthy, organism almost certainly leads to pus formation. The pus of all acute abscesses contains bacteria of suppuration, but the pus of tubercular abscesses does not, unless there be a mixed infection; in other words, pure tubercular pus is not pus at all.

Can suppuration be induced without micro-organisms? It is true that the injection of irritants can cause the formation of a thin fluid which contains no organisms, but is this non-bacterial pus really pus? The same sort of fluid is formed by injecting cultures of pus cocci which have been rendered sterile by heat, the organisms being killed, a ferment contained in the bacterial cells being the active agent. Spurious or "aseptic" pus does not concern us, as it is never found practically. Impaired health or an area of lowered vitality predisposes to suppuration. The lymphatic glands,

medulla of bones, serous membranes, and connective tissue are especially prone to suppurate.

Pus may form in twenty-four hours after bacteria are deposited, or it may not form for days. The older surgeons claimed that pus could do good by protecting granulations and separating disorganized tissue. It is now held that it is absolutely harmful by melting down sound tissue and poisoning the entire organism. Modern surgery has to a great degree abolished pus.

If pus stands for a time, it separates into two portions—(1) a watery portion, the liquor puris or pus-serum, containing peptone, fat, microbic products, osmazone, and salts, and not tending to coagulate; (2) a solid portion, or sediment of micro-organisms of suppuration, pus-corpuscles (Fig. 39), and

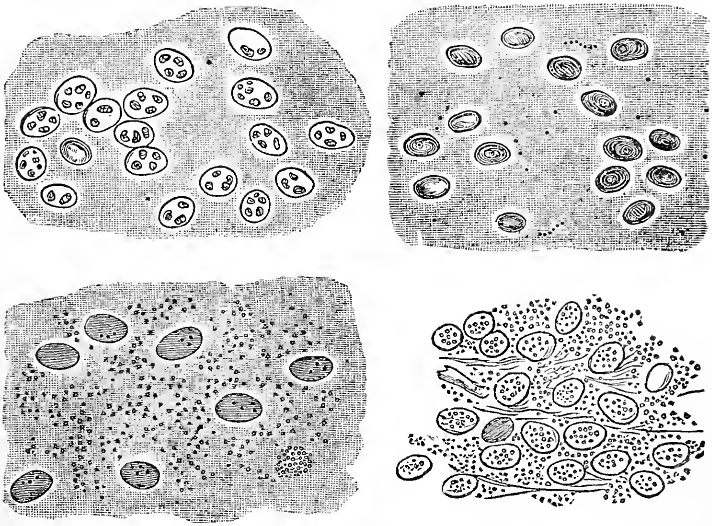


FIG. 39.—Fragmentation of nucleus in leukocytes undergoing transformation into pus-corpuscles (Senn).

broken-down tissue. The pus-corpuscles are either white blood-cells or altered connective-tissue cells. Some of them are dead, some have ameboid movements, some are fatty, others are granular and contain more than one nucleus, and all are degenerating. A pus-cell is waste-matter, and it cannot aid in repair.

Forms of Pus.—*Laudable* or *healthy pus*, a name long in vogue, is a contradiction, no pus being healthy. In former days free suppuration after an operation was regarded as a

favorable indication, and when it occurred the surgeon congratulated himself that surgical fever was at an end. At the present day suppuration after an operation is an evidence of previous infection, of lack of care, or of infection by the blood. The so-called laudable pus is seen coming from a healing ulcer, and is an opaque, yellowish-white or a greenish fluid of the consistence of cream, without odor or with a very slight odor if it is not putrid, and having a specific gravity of about 1.030.

Malignant, *watery*, or *ichorous pus* is a thin, watery, putrid fluid. It is pus filled with the organisms of putrefaction.

Stinking pus may be ichorous. If due to the bacterium coli commune, it is very foul, but not thin. Pus of this nature is met with in ischiorectal abscess and appendiceal abscess.

Sanious pus is a form of ichorous pus containing blood coloring-matter or blood. It is thin, of a reddish color, and very acrid, corroding the parts that it comes in contact with. It is found notably in caries and carcinoma.

Concrete or *fibrinous pus*, which contains flakes of fibrin or coagulated fibro-purulent masses, is met with in serous cavities (joints, pleura, etc.). These masses are found in infective endocarditis.

Blue pus.—The color of blue pus is due to the bacillus pyocyaneus.

Orange pus is due to the action of sarcina aurantiaca, and appears in violent inflammations.

Serous pus is a thin serous fluid containing a few flakes.

So-called *tubercular*, *scrofulous*, or *curdy pus* is not pus at all, unless the tubercular area has undergone pyogenic infection.

So-called *gummy pus* arises from the breaking down of a gumma which has outgrown its own blood-supply. It is not pus.

Muco-pus is found in purulent catarrh—that is, in suppurative inflammation of an epithelial structure. It contains pus-elements and epithelial cells.

Caseous pus comes from the fatty degeneration of pus-corpuscles or inflammatory exudations. It occurs especially in tubercular processes. A caseous mass may calcify.

Suppuration is announced by the intensification of all local inflammatory signs. The heat becomes more marked, the discoloration dusky, the swelling augments, the pain becomes throbbing or pulsatile, and the sense of tension is greatly increased. The skin at the focus of the inflammation after a time becomes adherent to the parts beneath, and fluc-

tuation soon appears. This adhesion of the skin is a preparation for a natural opening, and is what is known as "pointing." An important sign of pus beneath is edema of the skin. This is always observed in a superficial abscess, and is sometimes noticeable in empyema or pyothorax, in appendiceal abscess, and in perirenal suppuration. The above symptoms can be reinforced and their significance proved by the introduction of an aseptic tubular exploring-needle and the discovery of pus. Irregular chills, high fever, and drenching sweats are very significant of suppuration in an important structure or of a large area.

Diffused Cellulitis or Phlegmonous Suppuration; Purulent Infiltration.—This process may involve a small area or an entire limb, and is due to infection by the streptococcus pyogenes or streptococcus of erysipelas. The streptococci are intensely virulent. Barriers of white corpuscles will not restrain them, and tissues break down before cellular multiplication is able to encompass the bacteria. The bacteria disseminate through the lymph-spaces and lymph-vessels. The disease in severe cases produces enormous swelling, areas which feel boggy, a dusky-red discoloration, and great burning pain. Gangrene of superficial areas is not unusual, due to thrombosis of vessels or coagulation-necrosis from toxins. The discharges of the wound, if a wound exists, are apt to dry up, and the wound becomes foul, dry, and brown. The adjacent lymphatic glands are much enlarged. The disease is ushered in by a chill, which is followed by high oscillating temperature, due to suppurative fever, sapremia, or even septic infection or pyemia. Sweats are noted during falling temperature. Diffuse suppuration tends to arise in infected compound fractures, in extravasation of urine, and after the infliction of a wound upon a person broken down in health. It is not unusual after scarlet fever, and is typical of phlegmonous erysipelas. The pus is sanious and offensive, and burrows widely in the subcutaneous tissue and intermuscular planes. This diffused suppuration may widely separate muscles, and even lay bare the bones. It is a very grave condition, and may cause death by exhaustion, septic intoxication, septic infection, pyemia, or hemorrhage from a large vessel which has been corroded. Cellulitis of a mild degree may surround an infected wound or a stitch-abscess. Its spread is manifested by red lines of lymphangitis running up to the adjacent lymphatic glands. Light cases may not suppurate, the lymphatics carrying off the poison. Any case of cellulitis is,

however, a menace, and any severe case is highly dangerous (see Erysipelas).

Acute Abscesses.—An abscess is a circumscribed cavity of new formation containing pus. We emphasize the fact that it is a *circumscribed cavity*—circumscribed by a mass of leukocytes and proliferating connective-tissue cells. A purulent infiltration is not circumscribed, hence it does not constitute an abscess. An essential part of the definition is the assertion that the pus is in a cavity of *new* formation, in an abnormal cavity; hence pus in a natural cavity (pleural, pericardial, synovial, or peritoneal), constitutes a purulent effusion, and not an abscess unless it is encysted in these localities by walls formed of inflammatory tissue.

An acute abscess is due to the deposition and multiplication of pyogenic bacteria in the tissues or in inflammatory exudates. These bacteria attack exudates or tissues, form irritants which cause inflammation or intensify existing inflammation, and by exerting a peptonizing action on inter-

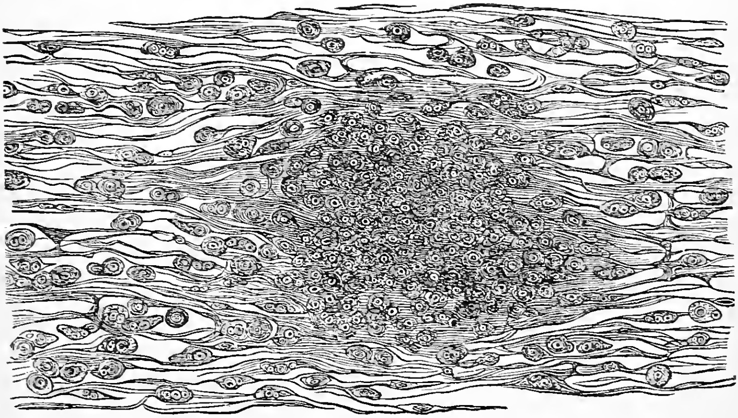


FIG. 40.—Infiltration of connective tissue of cutis (× 500) with beginning suppuration in the center (Senn).

cellular substance and the fibrin of the exudate liquefy tissue and the products of inflammation, and form pus. As a rule, within twenty-four hours after lodgement of the bacteria the exudation increases in amount, the migrated leukocytes gather in enormous numbers, the fibers of tissue swell up, and the connective-tissue spaces distend with cells and fluid. The connective-tissue cells, acted on by pus cocci, multiply by karyokinesis, develop many nuclei, lose their stellate projections, degenerate, and constitute one form of

pus-corpuscle, leukocytes forming the other. All the small vessels are choked with leukocytes, this blocking serving to cut off nourishment and tending to produce anemic necrosis. Liquefaction occurs at many foci of the inflammation, drops of pus being formed, the amount of each being progressively added to and many foci coalescing (Fig. 40). The pus-cavity is circumscribed, not by a secreting pyogenic membrane, but by a mass of fibroblasts, whose cells and intercellular material have not as yet broken down; such a mass of fibroblasts is often called embryonic tissue, and it is circumscribed by a zone of inflammation in which there are hordes of migrated leukocytes (Fig. 41). As an abscess increases in size the embryonic tissue from within outward liquefies into pus, and the zone of inflammation beyond continually enlarges and forms more embryonic tissue. After a time the inflammation reaches the surface, the embryonic tissue glues the superficial to the deeper parts, the superficial part inflames and becomes embryonic tissue, the intercellular substance is liquefied, a small elevation due to fluid pressure appears (pointing), and this elevation thins and breaks from tension and liquefaction (spontaneous evacuation).

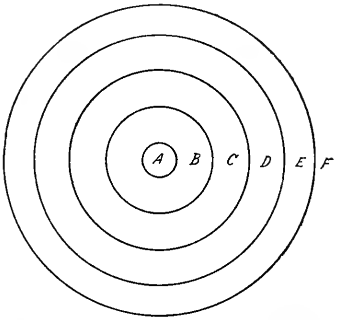


FIG. 41.—Diagram of an abscess: *A*, pus; *B*, layer of fibroblasts; *C*, tissue infiltrated with leukocytes; *D*, zone of stasis; *E*, zone of active hyperemia; *F*, healthy tissue.

When an abscess forms in an internal organ or in some structure which is not loose, like connective tissue—for instance, in a lymphatic gland—a mass of pyogenic bacteria, floating in the blood or lymph, lodges, and these bacteria by means of irritant products cause coagulation-necrosis of the adjacent tissue and inflammatory exudation around it. The area of coagulation-necrosis becomes filled with white blood-cells, and the dry necrosed part is liquefied by the cocci. Suppuration in dense structures causes considerable masses of tissue to die and to be cast off, and these masses float in the pus. Death of a mass with dissolution of its elements is necrosis, or inflammatory gangrene. Pus travels in the line of least resistance. It may reach a free surface, or may break into a cavity or joint, may invade bone or destroy a vessel. When an abscess ceases to spread or is evacuated,

the cellular tissue forming the walls becomes vascularized (granulation-tissue). An abscess heals by the collapse of its walls and fusion of the granulations (union by third intention), or by granulation (union by second intention). In either case granulation-tissue is ultimately converted into fibrous or scar-tissue.

Forms of Abscesses.—The following are the various forms of abscesses: *acute*, which follows an acute inflammation; *strumous, cold, lymphatic, tubercular*, or *chronic* abscess is due to tubercle, and does not contain true pus unless there is secondary infection. It presents no signs of inflammation. A lymphatic abscess may form in a week or two, and hence is not necessarily chronic, which term may also be used to mean a persistent non-tubercular abscess; *caseous* or *cheesy* abscess, a cavity containing thick cheesy masses, is due, perhaps, to the fatty degeneration of inflammatory exudate and pus-corpuscles, but most commonly results from the caseation of a tubercular focus; *circumscribed* abscess is one limited by embryonic tissue; *diffused* abscess is an unlimited collection of pus, in reality not an abscess, but either a purulent effusion or a purulent infiltration; *congestive, gravitative, wandering*, or *hypostatic* abscess is a collection of pus or tubercular matter which travels from its formation-point and appears at some distant spot (as a psoas abscess); *critical* or *consecutive* abscess is one which arises during an acute disease; *diathetic* abscess is due to a diathesis; *embolic* abscess is due to an infected embolus; *tympanitic* or *emphysematous* abscess is one which contains the gases of putrefaction; *encysted* abscess, in which pus is circumscribed in a serous cavity; *fecal* or *stercoraceous* abscess is one containing feces in consequence of a communication with the bowel; *follicular* abscess is one arising in a follicle; *hematic* abscess, one arising around blood-clot, as a suppurating hematoma; *marginal* abscess, which appears upon the margin of the anus; *pyemic* or *metastatic* abscess is the embolic abscess of pyemia; *milk* abscess is an abscess of the breast in a nursing woman; *ossifluent* abscess, arising from diseased bone; *psoas* or *tubercular* abscess, arising from vertebral caries, the matter following the psoas muscle and usually pointing in the groin; *sympathetic* abscess, arising some distance from the exciting cause, such as a suppurating bubo from chancroid, is not in reality sympathetic, because infective material has been carried from the primary focus; *thecal* abscess is suppuration in a tendon-sheath; *tropical* abscess is an abscess of the liver, so named because it occurs chiefly in

tropical countries: it usually follows dysentery; *urinary* abscess, caused by extravasated urine; *verminous* abscess, one which contains intestinal worms and communicates with the bowel; *syphilitic* abscess, which occurs in the bones during tertiary syphilis, and which is gummatous and not pyogenic; *Brodie's* abscess is a chronic abscess of a bone, most common in the head of the tibia; *superficial* abscess, which occurs above the deep fascia; *deep* abscess, occurring below the deep fascia; and *residual* or *Paget's* abscess, a recurrence of active changes, it may be after years, about the residue of a former tubercular abscess.

Symptoms of Acute Abscess.—In an acute abscess, as before stated, a part becomes inflamed and embryonic tissue forms; this is liquefied (as above noted) and pus is produced. If the abscess is in the brain, in the tonsil, or in the neighborhood of the rectum or vermiform appendix, the odor of the pus is apt to be offensive. An acute abscess can occur in a person of any constitution.

Local Symptoms.—Locally there is intensification of inflammatory signs, and swelling enormously increases. At first the area is hard, but afterward becomes soft and finally fluctuates. The discoloration becomes dusky. The pain becomes throbbing and the sense of tension increases. The pain is greater the more dense the implicated tissue is and the greater the number of nerves it contains. At every pulsebeat the tension in the abscess increases temporarily, and hence the pain momentarily increases. Pain is increased by a dependent position of the part. There is great tenderness. The pain may be felt at the seat of suppuration or may be referred to some distant point. Tenderness is located at the focus of disease. The cutaneous surface is seen to be polished and edematous, and after a time pointing is observed and fluctuation can be detected.

Constitutional Symptoms.—In cases of small collections of pus in unimportant structures there may be no obvious constitutional disturbance. If the abscess contains much pus or affects an important part, disturbances generally appear, from slight rigors or moderate fever to chills, high temperature, and drenching sweats. The constitutional condition typical of an abscess is due to the absorption of retained toxins, and is known as "suppurative fever." When suppuration is long continued there exists a fever which is markedly periodic: the temperature rises in the evening, attaining its highest point usually between 4 and 8 P. M., and then sinks to normal or nearly normal in the early morning (from 4 to

8 A. M.). When the temperature begins to fall profuse perspiration takes place. This fever is known as "hectic." Prolonged suppuration causes albuminoid changes in various organs, notably in the liver, spleen, and kidneys.

The signs and symptoms of an abscess are somewhat modified by location, and it is wise to discuss acute abscesses in different situations.

Acute Abscesses in Various Regions.—*Abscess of the brain* in about 50 per cent. of cases results from suppurative disease of the middle-ear. In *abscess* of a silent region of the *brain* symptoms may long be entirely absent. The usual symptoms are headache, vomiting, delirium, drowsiness, optic neuritis, and often a subnormal temperature. Localizing symptoms may be present. In but few cases are there fever and sweats. In extradural abscess there is fever.

Appendiceal or *appendicular abscess* results from inflammation, usually with perforation of the vermiform appendix, plastic peritonitis circumscribing the pus. If the pus has been formed by colon bacilli or staphylococci, it will probably be circumscribed and limited by cellular exudate, which glues together the mesentery and coils of small intestine. If the pus has been formed by streptococci, it will probably not be limited, and the peritoneum will be attacked by diffuse septic peritonitis. The signs of appendicular abscess are pain, tenderness, muscular rigidity, the existence of a mass, dulness on percussion, and sometimes fluctuation and skin-edema in the right iliac fossa, fever, vomiting, sometimes constipation, and sometimes diarrhea.

Abscess of the liver may not be announced by symptoms until rupture. It may follow dysentery, may be a result of the lodgement of infected clots from the hemorrhoidal veins, may follow upon the infective phlebitis of appendicitis, may result from septic cholangitis or suppuration of a hydatid cyst. We usually find fever of an intermittent type, profuse sweats, pain in the back, the shoulder, or the right hypochondraic region, enlargement of the area of liver-dulness, also hepatic tenderness, and finally constitutional symptoms of the existence of pus. Sometimes there are fluctuation and skin-edema over the liver, and the general cutaneous surface may be a little jaundiced. The symptoms vary as the pus invades adjacent organs. Where there are pain on respiration and evidences of diaphragmatic pleuritis the pus is probably breaking into the pleural sac.

Subphrenic abscess is apt to begin beneath the diaphragm, though in some few instances the pus forms above this mus-

cle, and subsequently gains access to the region beneath, Such an abscess may contain not only pus, but gas, and in some cases also fluid from the stomach or intestine. It may arise after perforation of the bowel or stomach, or it may result from Pott's disease, perinephric abscess, traumatism, abscess of the liver, kidney, spleen, or pancreas, empyema or pneumonia (Greig Smith). The signs are pain, fever, sweats, dyspnea, cough, and the physical signs of a collection of fluid beneath the diaphragm and of gas in the cavity of the abscess.

Abscess of the lung gives the physical signs of a cavity; the expectoration is offensive and contains fragments of lung-tissue. An abscess may occasionally be located by the use of the X-rays. Pyemic abscesses may exist and yet escape discovery.

Abscess of the mediastinum causes throbbing retrosternal pain, chills, fever, sweats, and often dyspnea. A tumor may appear which pulsates and fluctuates, but the pulsation is not expansile.

Perinephric abscess usually causes tenderness and pain in the lumbar region or about the hip-joint, which pain runs down the thigh and is accompanied by retraction of the testicle. Induration, fluctuation, or edema of the skin may be observed in the lumbar region, and there is tenderness in the loin. The constitutional symptoms of suppuration usually exist.

Abscess of the antrum of Highmore causes pain, edematous swelling of the bone, and crepitation on pressure upon the superior maxillary bone. Pus may escape from the nostril of the diseased side when the head is bent in the direction of the healthy side. A rhinoscopic examination discloses the fluid passing into the nares. The antrum on the side of the abscess cannot be transilluminated by an electric light in the mouth (Garel's sign).

Abscess of the larynx induces violent cough, pain, interference with the voice, swallowing, and breathing, and can be seen with a laryngoscope.

An *ischiorectal abscess* is situated in the areolar tissue of the ischiorectal fossa. The pyogenic organisms usually gain entrance to the lymphatics by way of an abrasion, fissure, or ulceration of the rectum or anus. In rare cases they reach the fossa in the blood-stream. The pain is severe and throbbing; there are great tenderness, redness and edema of skin, induration, and usually the constitutional symptoms of

pus formation. Fluctuation is a very late sign because of the density of the fascia.

Prostatic abscess is manifested by chills, fever, sweats, frequency of micturition, tenderness of the perineum and rectum, and agonizing pain, developing during an attack of acute prostatitis.

Abscess of the breast can arise from absorption of pyogenic bacteria from a fissure or abrasion of the nipple. Some surgeons maintain that the bacteria enter along the milk-ducts, while others assert that they gain entrance by the lymphatics. It is most common in nursing women. Its symptoms are pulsatile pain, dusky discoloration, skin-edema, fluctuation, and usually constitutional disorder.

Suppurative thecitis or *felon* is a form of diffuse suppuration (p. 623).

Palmar abscess is a purulent effusion (p. 621).

Furuncle and carbuncle are discussed on pages 916 and 917.

Empyema is a purulent effusion into the pleural sac (p. 724). It is technically an abscess if it becomes encapsuled.

Diagnosis.—The diagnosis of an abscess rests upon—(1) its history; (2) fluctuation; (3) pointing; (4) surface-edema; and (5) the use of the tubular exploring-needle.

Fluctuation is the sensation imparted to a finger held against a sac containing fluid when a wave is started in the fluid by striking the mass with a finger of the other hand. Fluctuation cannot be obtained if the amount of fluid is small. It should never be sought for across a limb, but rather along it.

A suspected abscess in a part containing large blood-vessels under no circumstance should be opened by a bistoury without knowing that the diagnosis is certainly correct. This knowledge is obtained in some cases by inserting a small aspirating-needle and observing the nature of the fluid which exudes. An abscess which moves with the pulse because it rests upon an artery may be confounded with an aneurysm. The pulse-movements of such an abscess are in one direction only; the abscess is lifted with each pulse-beat, but does not enlarge, and if a finger is laid upon either side of it the fingers will be lifted but not separated. The pulse-movements of an aneurysm are in all directions; they are expansile, the tumor grows larger, and the fingers will not only be lifted, but will also be separated. The tubular exploring-needle can be used in doubtful cases; if aseptic, it will do no harm even to an aneurysm. Many able surgeons

object to the employment of a grooved exploring-needle, on the ground that when plunged into infected areas and withdrawn the track of the penetration becomes infected by the fluid which escapes. A rapidly growing, small-cell sarcoma feels not unlike an abscess; but the exploring-needle discovers blood, and not pus. A cystic tumor is separated from an abscess by the absence of inflammation, or, if it inflames, by the nature of the contained fluid. Ordinary caution will prevent one confounding an abscess with strangulated hernia. A tubercular abscess is separated from an acute abscess by the absence of inflammatory signs in the former. The contents of the acute abscess differ from those of the chronic abscess. When an abscess exists in an important region (brain, appendix, liver, etc.), cultures of the

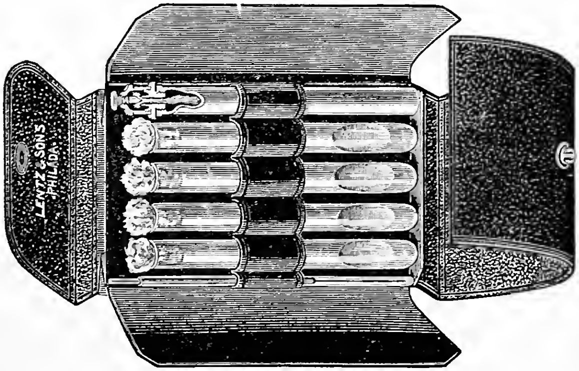


Fig. 42.—Vischer's case for carrying culture-tubes for inoculation.

pus should be taken after incision. Such studies often give valuable information as to the probable course of the condition, and an accumulation of many accurate observations will add greatly to scientific information. Fig. 42 shows a convenient case for carrying culture-tubes.

Prognosis.—The prognosis varies according to the number of abscesses, their location and size, the strength of the patient, and the virulence of the causative bacteria.

Treatment.—In the treatment of an abscess there is one absolute rule which knows no exception, namely, that whenever and wherever pus is found the abscess should be evacuated at once, and, after evacuating it, thorough drainage must be provided for. It should be opened early, if possible even before pointing or fluctuation, to prevent tissue-destruction, subfascial burrowing, and general contamination. Drainage

is continued until the discharge becomes scanty, thin, and seropurulent.

Abscess of the liver requires that an incision be made along the edge of the ribs down to the liver, which organ is then stitched to the edges of the wound. In a day or two after the first operation the two layers of peritoneum are firmly adherent and the abscess can be opened without danger of the passage of pus into the peritoneal cavity. The abscess is opened and washed out, and a tube inserted. Surgeons occasionally try to locate the pus by the use of an aspirator before doing the cutting operation. Abscess of the liver is occasionally reached by resecting a rib, opening the pleural sac, and incising the diaphragm (transthoracic hepatotomy). Abscess of the mediastinum, like all other abscesses, requires incision and drainage. This is effected by cutting between the rib cartilages or by trephining the sternum. In *abscess of the lung* an incision is made and the pleura is exposed. The incision is usually through an intercostal space; but if the spaces are narrow, it will be necessary to resect a rib. If the two layers of pleura are found adherent, the operation is proceeded with. If they are not adherent, they are stitched together with a catgut suture, and the surgeon waits 48 hours before continuing. The operation is completed by locating the pus by means of an aspirator, evacuating it by the cautery at a dull-red heat, and inserting a drainage-tube into the abscess-cavity. In *abscess of the antrum of Highmore* bore a gimlet-hole through the superior maxillary bone, above the canine tooth, or perforate the bone by means of a trocar. Irrigate daily with boiled water or normal salt solution. Keep the opening from contracting by inserting a small tent of iodoform gauze. In persistent cases it may be necessary to draw a tooth, break through the socket into the antrum, and insert a silver or hard-rubber tube. In very persistent cases osteoplastic resection of a portion of the upper jaw will be demanded. In *appendicular abscess* incise, support the abscess-walls with gauze, remove the appendix in most cases, but not in all, and insert a drainage-tube and strands of gauze

An *ischiorectal abscess* must be opened early. The surgeon never waits for fluctuation. Fluctuation is a very late symptom. To wait for it entails great destruction of tissue and serves no useful purpose. Place the patient on his side, with the legs drawn up. Insert a finger in the rectum, lift the abscess toward the surface and incise it from the surface.

The incision runs from the anal margin like a spoke from the hub of a wheel. Irrigate with salt solution, inject iodoform emulsion, insert a drainage-tube, dress, and let the patient know he is in danger of developing a fistula.

In *abscess of the breast* make an incision radiating from the nipple, or, what is better, incise under the breast by means of a cut at the inferior thoracic mammary junction, and enter the abscess from beneath. In *abscess of the brain* the skull should be trephined, the membranes incised, and the abscess sought for, opened, and drained (p. 677). In an ordinary *superficial abscess*, after cleansing the parts, make the skin tense, and incise with a sharp-pointed curved bistoury at the most dependent part of the abscess. Permit the pus to run out itself; pressure, as a rule, is undesirable. If tissue-shreds block the opening, they must be picked out with forceps. If the atmospheric pressure will not cause the pus to flow out, make light pressure with warm, moist, aseptic sponges. After the pus has come away wash the cavity with normal salt solution or boiled water, and drain with a tube for two or three days, when the discharge becomes serous. Pursue rigid antisepsis in dealing with purulent areas. It is true we already have infection with pyogenic bacteria, but infection can also take place with organisms of putrefaction, causing pus to become putrid, or with other bacteria, for instance, those of tetanus. It is not desirable to overdistend the abscess-cavity with fluid, because the hydrostatic pressure might break down the wall of young cells and infection be diffused. Do not irrigate with powerful disinfectants. They cannot be used strong enough to really disinfect, but may easily be used strong enough to cause necrosis of an abscess-wall. Peroxid of hydrogen is not to be used unless the incision is large. If an abscess contains putrid pus, after evacuation irrigate with hot salt solution or peroxid of hydrogen and inject iodoform emulsion. If a tube is not used and the cavity is packed with iodoform gauze, remember that gauze will not drain pus and requires to be changed once a day. An abscess should be dressed with hot, moist antiseptic dressings (antiseptic fomentation). When the discharge becomes thin and scanty, dry aseptic or antiseptic dressings are used.

In a *deep abscess* or an abscess situated near important vessels, do not boldly plunge in a knife. Hilton says to "plunge in a knife is not courageous, as it is without danger to the surgeon, but may be fatal to the patient." Remember also that a large amount of pus displaces normal anatomical relations. Hilton's method of opening a deep abscess (as in

the axilla or neck) is to cut to the deep fascia, nick the fascia with a knife, and then push into the abscess a grooved director until pus shows in the groove; along the groove push a pair of closed dressing-forceps; after they reach the depths open them and withdraw them while open, and so dilate the opening; then insert a tube and irrigate. In an abscess in the posterior part of the orbit, after incising transversely a portion of the upper lid, the abscess should be reached by this method. Always endeavor to open an abscess at its most dependent part, remembering that the situation of this part may depend upon whether the patient is erect or recumbent. If we do not make the opening at the lowest point, all the pus will not run out and the walls will not completely collapse. A deep abscess must be drained thoroughly until the discharge becomes seropurulent. When the tube is removed it is wise to insert a tent of iodoform gauze just through the outlet of the abscess. This tent prevents the skin from closing over the channel. It is removed and a new one is inserted every day until it is clear that there is no longer danger of fluid becoming blocked and retained. When an abscess contains diverticula or pouches they should be slit up or a counter-opening ought to be made. A counter-opening is made by entering the dressing-forceps at the first incision, pushing them through the abscess to the point where we wish to make our counter-opening, opening the blades, and cutting between them from without inward. The blades are then closed and projected through the incision; they are opened to dilate the new door, and closed again upon a drainage-tube, which is pulled through from opening to opening as the instrument is withdrawn. When pus burrows, insert a grooved director in each channel and slit the sinus with a knife. An abscess may make an opening through dense fascia, the opening being small like the neck of an hour-glass (shirt-stud abscess). Always examine to see if such a condition exists, and if it is found, incise the fascia.

In a deep abscess in which the pus is putrid frequent irrigation is desirable. In such a case two tubes may be employed (Fig. 43). The tubes are prevented from slipping in by the use of a safety-pin. The irrigating fluid is passed into the cavity (*d*) through the tube *b*, and it runs out through the tube *c*.

Rest is of the first importance in the healing of an abscess, and we try to obtain it by bandages, splints, and pressure, which will immobilize adjacent muscles and approximate the abscess-walls. If an abscess is slow to heal, use as a

daily injection a solution of corrosive sublimate of the strength of 1 : 1000, or 3 drops of nitric acid to ℥j of water, or 3 grains of zinc sulphate to ℥j of water, or a 5 per cent. solution of carbolic acid, or a 2 per cent. aqueous solution of pyoktanin, or 20 drops of tincture of iodin to ℥j of water, or a solution of bichlorid of palladium. Peroxid of hydrogen is a dangerous agent to inject into the cavity of a deep abscess of the neck, as the liberated gas may not escape from

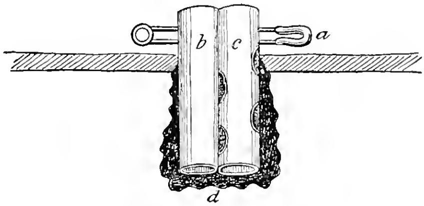


FIG. 43.—Drainage-tubes for abscess requiring irrigation.

the opening, but may pass widely into the tissues and cause great distention. The author saw a child who narrowly escaped death after such an injection. In this patient the gas passed beneath the pharyngeal mucous membrane and the swelling almost occluded the air-passages. The constitutional treatment of an abscess depends upon its severity and upon the importance of the structures involved. In a bad case the patient should be put to bed, opiates given with a free hand, the bowels kept active by calomel and salines, skin-activity maintained, nutritious food insisted on, and stimulants liberally employed.

Purulent Effusions.—(See Suppurative Thecitis, Palmar Abscess, Suppurative Synovitis, Purulent Peritonitis, Empyema, etc.).

Tubercular abscess, called also chronic, cold, scrofulous, and lymphatic, is an area of disease produced by the action of the bacilli of tubercle and circumscribed by a distinct membrane. Ashhurst says that the term "chronic" is a bad one. "It refers etymologically only to time. A phlegmonous abscess, if deeply seated, may be of slower development than a chronic or cold abscess which is superficial." A tubercular abscess is most common in connection with tubercular disease of the lymphatic glands, bones, joints, and subcutaneous connective tissues, and is rare after the twentieth year. It may contain quarts of curdy pus. The bacilli of tubercle cause inflammation, and granulation-

tissue is formed, which in the center undergoes coagulation-necrosis and caseation, and at the periphery is converted into fibrous tissue containing tubercles. The mass of granulation-tissue undergoes necrosis in the center, chiefly because of the direct action of the toxins and partly because the capillaries are gradually lessened in caliber. The necrotic mass undergoes fatty degeneration (caseation). If caseated tubercular granulation-tissue liquefies, scrofulous, curdy, or tubercular pus is formed, and the growing collection of fluid is called a tubercular or cold abscess. Such an abscess does not contain true pus. The tubercle bacillus is not a pyogenic organism. If true pus forms, it is because of a secondary infection with pus-cocci—an accident, and not a part of the natural process of formation of a cold abscess. A cold abscess is filled with liquefied caseated tubercle, masses of coagulated fibrin, and bits of necrotic tissue. The wall of a cold abscess consists of granulation-tissue and fibrous tissue, the granulation-tissue being in the interior. The yellowish granulation-tissue lining a cold abscess is filled with miliary tubercles, and is called Volkmann's membrane. The fibrous wall was formerly called the pyogenic membrane, because of the mistaken notion that it secreted purulent material. A cold abscess may be absorbed or may become encapsuled by densely fibrous organization of its limiting wall. It may enlarge greatly and involve various tissues. Tubercular matter rarely invades a muscle, whereas syphilis often attacks muscle (Warren).

Symptoms.—The term *cold* abscess is employed for a tubercular abscess because it presents no inflammatory signs. There is no local heat; no discoloration unless pointing occurs; the parts look paler than natural; pain is absent in the abscess, though it may exist at the point of origin of the fluid. The tubercular material often wanders from its point of origin under the influence of gravity. Fluctuation is present unless thick walls mask it. Constitutional symptoms are trivial or absent unless secondary infection occurs. The swelling may suddenly appear in some spot—the groin, for instance. When it appears suddenly it has travelled from a distant and older area of disease. The abscess may last for years without producing pain or annoyance. The introduction of a tubular exploring-needle will settle the diagnosis. The constitution is invariably below normal because of the tubercular infection, and the temperature may be a little above normal. A cold abscess which is infected with putrefactive or pyogenic organisms exhibits great inflammation,

and sapremia or septicemia rapidly develops. In tubercular disease of the vertebræ the fluid may find its way to the lumbar region, to the iliac region, or to the immediate neighborhood of Poupart's ligament, above or below it.

Tubercular Abscesses in Various Regions.—**Tubercular abscess** of the head of a bone (Brodie's abscess) arises in the cancellous structure of a long bone, most often in the head of the tibia. Pain is continued but not usually very severe, is of a boring character, and is worse when the patient is in bed. Attacks of synovitis arise from time to time in the adjacent joint. There is no such thing as an acute abscess of bone. A pyogenic inflammation of such severity that it would cause an acute abscess in soft parts, in bone causes acute necrosis. The tubercular organisms obtain access to the bone by means of the blood, and find in the bone a point of least resistance.

Retropharyngeal or postpharyngeal abscess is, as a rule, but not always, tubercular. Such an abscess is usually due to caries of the cervical vertebræ, but can arise in the connective tissue of the parts or as a tubercular adenitis. An abrasion of the mucous membrane may admit the bacilli to the connective-tissue or the glands. A swelling projects from the posterior pharyngeal wall, and there is great interference with respiration and deglutition. Caseous matter from caries of the cervical vertebræ may reach the posterior mediastinum by following the esophagus, or it may appear in front of or behind the sternomastoid muscle (Edmund Owen).

Dorsal Abscess.—The tubercular matter in dorsal abscess arises from dorsal caries, flows into the posterior mediastinum, and reaches the surface by passing between the transverse processes. The tubercular matter from dorsal caries may run forward between the intercostal muscles or between these muscles and the pleura, pointing in an intercostal space at the side of the sternum or by the rectus muscle. It may open into the gullet, windpipe, bronchus, pleural sac, or pericardium. It may descend to the diaphragm and travel under the inner arcuate ligament to form a psoas abscess, or under the outer arcuate ligament to form a lumbar abscess. A psoas abscess points external to the femoral vessels, a characteristic which distinguishes it at once from a femoral hernia.

Iliac abscess arises from lumbar caries, the swelling lying in the iliac fossa and pointing above Poupart's ligament.

Psoas abscess is usually due to lumbar caries, but may arise from dorsal caries. The fluid usually points in Scarpa's

triangle external to the femoral vessels, but may descend much lower (Fig. 44). A psoas or iliac abscess, by following the lumbosacral cord and great sciatic nerve, forms a gluteal abscess. These abscesses may open into the bowel, bladder, ureter, or peritoneal cavity.

Lumbar Abscess.— In a lumbar abscess the fluid produced by dorsal caries descends beneath the outer arcuate ligament, or the fluid from lumbar caries which collected anterior to or in the quadratus lumborum muscle passes between the last rib and iliac crest in the triangle of Petit, the small space bounded by the crest of the ilium, the posterior edge of the external oblique muscle, and the anterior edge of the latissimus dorsi muscle.[1]

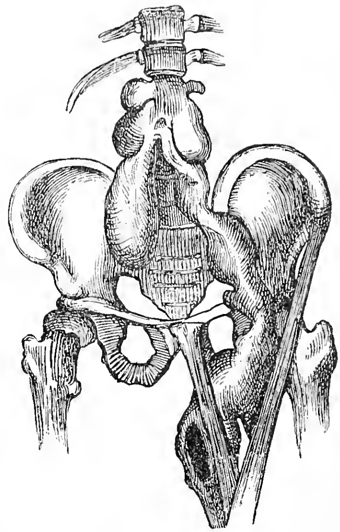


FIG. 44.—Psoas abscess (Albert).

Chronic abscess of the breast is a caseated area of tuberculosis of the breast. A lump is detected, which slowly enlarges and finally ruptures, sinuses being formed. The axillary glands are apt to be implicated. The patient belongs to a tubercular stock, as a rule gives a history of previous tubercular troubles of various sorts, and has usually borne children. Chronic abscess of the breast causes little or no pain.

Treatment of Tubercular Abscess.—If a small cold abscess exists in a superficial structure, open it with aseptic care, rub its walls with bits of gauze to remove tubercular masses, irrigate with 1 : 1000 mercurial solution, inject with iodoform emulsion, pack with iodoform gauze, and dress antiseptically. When the discharge becomes thin and scanty the packing can be dispensed with. If it be slow in healing, inject or swab out with a stimulating fluid as in acute abscess, or inject with iodoform emulsion.

Chronic Abscess of Bone.—Make an incision to bare the bone. Open the abscess with the trephine, the gouge, or the chisel; curet with a sharp spoon and gouge; cut away

[1] For a lucid description of these abscesses see Owen's *Manual of Anatomy*, from which much of the above is condensed.

the edges of the bone with rongeur forceps; irrigate the cavity with hot corrosive sublimate solution (1 : 1000), dry its walls with gauze, and paint the cavity with pure carbolic acid; pack with iodoform gauze and apply antiseptic dressings. It is better not to employ an Esmarch apparatus. Bleeding will not be severe, and when no apparatus is used one can be sure that all the diseased bone has been removed, because sound bone bleeds and dead bone does not.

Cold Abscess of Lymphatic Glands.—In non-exposed portions of the body the capsule of the gland should be incised and dissected or scraped away, and the cavity swabbed out with pure carbolic acid and packed with iodoform gauze. If the abscess is allowed to burst, it will cause an ugly scar; therefore in exposed portions of the body an effort should be made to prevent a scar by incising early before the skin is involved. When only a little caseated matter exists and the skin is not discolored, prepare the parts antiseptically, incise, rub the interior with gauze, inject iodoform emulsion, use a small drainage-tube, and suture the wound. It used to be a custom in such cases to carry a silk thread by means of a needle through the skin, through the gland, and out at its lowest point, the part being then dressed with gauze. In three days the thread was removed and a firm compress was applied. The plan is not satisfactory and incision is to be preferred. When the gland is almost entirely broken down and the skin above it is purple and thin, insert a hypodermatic needle through sound skin into the abscess, draw off the pus, and inject iodoform emulsion (10 per cent. of iodoform, 90 per cent. of glycerin or olive oil). This procedure is to be repeated when pus again accumulates. By this means we can sometimes effect a cure in a week or so. When an abscess breaks or is at the point of breaking cut away all purple skin, curet the abscess-walls (the abscess having become a tubercular ulcer), remove the remains of gland and capsule, swab the cavity with pure carbolic acid, and dress with iodoform and antiseptic gauze.

Tubercular glands ought to be extirpated before they caseate and form an abscess.

Cold Abscess of Mammary Gland.—Many operators simply incise, curet, pack with iodoform gauze, and dress antiseptically. It is wiser to remove the entire gland, and to clean out the axilla, as in an operation for cancer, in order to prevent both recurrence and dissemination.

Large Cold Abscesses (Psoas Abscess).—In view of the

facts that these abscesses may cause no trouble for years and that an operation may be fatal, some eminent surgeons are opposed to an operation unless the abscess is moving toward inevitable rupture or is disturbing the functions of organs by pressure. Most practitioners believe, however, that this mass of tubercular matter is a source of danger through being a dépôt of infective organisms which may overwhelm the system, and that death will rarely occur in the hands of the operator who employs with intelligence strict antisepsis. In no other cases is attention to every detail more important, as a mixed infection can easily take place, and will probably mean death.

In many cases aspiration can be employed to empty the cavity, injecting either a 10 per cent. iodoform emulsion to the amount of ℥iij, or ℥iij of a 5 per cent. ethereal solution of iodoform after the tubercular fluid has been sucked out. After injecting the emulsion squeeze and manipulate the fluid into every nook and cranny. The *American Text-book of Surgery* advises the injection of from 1 to 3 ounces of the following preparation: iodoform, 10 parts; glycerin, 20; mucil. gum Arab., 5; carbolic acid, 1; water, 100.

Whatever fluid is chosen, the operation must be repeated three or four times at intervals of four weeks. It is dangerous to inject large amounts of iodoform, as poisoning may be produced (p. 29). Some surgeons incise such an abscess, inject iodoform emulsion, and sew up without drainage. Such a procedure may succeed, may fail, and is sometimes followed by iodoform-poisoning. If aspiration and injection fail, open, under rigid antisepsis, the most dependent portion of the abscess, scrape its wall with bits of gauze, and overdistend with a 1 : 1000 solution of warm corrosive sublimate. Let the mercurial solution run out and then irrigate the cavity with hot normal salt solution, which will remove the remains of the corrosive fluid. With a long probe find the highest point of the cavity, and make a counter-opening; scrape well. It is useless to remove carious vertebræ. Flush the whole area with corrosive sublimate, wash out the mercurial solution with hot normal salt solution, inject emulsion of iodoform, and either make tube-drainage from opening to counter-opening and from bone to counter-opening, or pack the entire cavity with iodoform gauze. If hemorrhage is severe, after injecting with hot salt solution the cavity must be packed. When a large abscess breaks of itself, it should at once be drained and asepticized as above. In the treatment of a cold abscess give nutritious food, cod-

liver oil, quinin, iron, and the mineral acids. Removal to the seaside is often indicated, and mechanical appliances may be needed for diseases of the bones and joints. If secondary infection does occur, the patient develops septic fever and almost certainly dies (*q. v.*).

Dorsal abscess and lumbar abscess are treated after the same plan as psoas abscess, although one incision only is usually necessary unless the fluid has travelled to a distant point.

A postpharyngeal abscess must not be opened through the mouth. To open it in this manner puts the patient in danger of suffocation by fluid running into the larynx during or after the operation. Further, mixed infection of the abscess-area will be certain to ensue. Septic pneumonia will be apt to arise from inhaled infected particles, and profound gastro-intestinal disturbance will be liable to develop because of the inevitable swallowing of purulent, putrid, and tubercular masses. Incise the neck and open into the abscess by Hilton's method, going through the sternocleidomastoid muscle or behind it. Rub the wall of the abscess with bits of gauze, remove any loose bone, irrigate with hot normal salt solution, inject iodoform emulsion, insert a tube or pack with iodoform gauze.

VII. ULCERATION AND FISTULA.

An **ulcer** is a loss of substance due to molecular death of a superficial structure. The molecular death is brought about by bacteria. Ordinary ulcers are caused by pus organisms. The action of the pus organisms is the same as in an abscess. A broken abscess becomes an ulcer, and an ulcer is in structure a half-section of an abscess. The floor of an ulcer consists of granulation-tissue and corresponds with the abscess-wall. An abscess arises from molecular death within the tissues; an ulcer, from molecular death of a free surface. An ulcer may increase in size by molecular death of adjacent structures or by sloughing, that is to say, by death of visible masses of tissue. A wound healing by granulation is often wrongly called an ulcer. An ulcer must not be confounded with an excoriation. In an ulcer the corium is always, and the subcutaneous tissue is generally, destroyed, and a scar is left after healing. In an excoriation the mucous layer of epithelium is exposed, or this is destroyed and the corium exposed. In an excoriation the corium is never destroyed, and no scar

remains after healing. An ulcer heals by granulation (p. 109). Embryonic tissue by vascularization becomes granulation-tissue, granulation-tissue is converted into fibrous tissue, the fibrous tissue contracts, and by pulling the edges of the ulcer toward each other lessens the size of the cavity. When the granulations reach the level of the skin the epithelium at the edges of the ulcer proliferates and the sore is soon covered over with new epithelium.

Necrosis of a superficial part may arise from—(1) Inflammation. The pressure of the exudate can cut off the circulation, or bacteria may directly destroy tissue. Suppuration occurs. (2) The action of pus bacteria, causing primary cell-necrosis. (3) Bacteria of putrefaction and organisms of suppuration acting upon a wound. (4) Traumatism or irritants, producing at once stasis, which is added to by secondary inflammation, the exudate undergoing purulent liquefaction. (5) Prolonged pressure. (6) Deficient blood-supply. (7) Faulty venous return. (8) Degeneration of a neoplastic infiltration (gummatous, malignant, or tubercular). (9) Trophic disturbance. (10) Nutritional disturbances (as scurvy). Most ulcers are due to pus organisms, and even areas of necrosis that arise from something else (as gummatous degeneration) are likely to suppurate.

Classification.—Ulcers are classified into groups according to the condition of the ulcer and the associated constitutional state. In the first group we find the varicose, hemorrhagic, acute, chronic, irritable, neuralgic, etc. In the second group are placed the tubercular, syphilitic, senile, scorbutic, etc. All ulcers, whatever their origin, are either *acute* or *chronic*, and such conditions as great pain, hemorrhage, edema, exuberant granulations, phagedena, sloughing, eczema, gout, syphilis, scurvy, etc., are to be looked upon as complications. The leg is so common a site of ulcers as to warrant a special description of ulcers of this part. In describing an ulcer state the patient's previous history; the supposed cause; the situation; the outline; the duration; and the mode of onset of the ulcer. State if the ulcer is single or if multiple sores exist, and if there is or is not pain. Whether or not any healing has ever occurred, and the patient's constitutional condition. Set forth the complications; the state of anatomically related glands; the condition of the edge, the floor, and the parts about the ulcer, and the nature and quantity of the discharge.

Acute or **inflamed ulcer of the leg** may follow an acute inflammation and may be acute from the start, or may

be first chronic and then become acute. It is especially common in drunkards and among those of dilapidated constitutions. It is characterized by rapid progress and intense inflammation. There is rarely more than one ulcer. In outline these ulcers are usually oval, but may be irregular. The floor of an acute ulcer contains no granulations, but is composed of the raw and inflamed tissues, or is covered with a mass of gray aplastic lymph, or it may have upon it large greenish sloughs. The edges are thin and undermined. The discharge is very profuse and ichorous, excoriating the surrounding parts. The adjacent cutaneous surface is inflamed and edematous, and there is much burning pain. In some cases the glands in the groin enlarge. Constitutionally, there is gastro-intestinal derangement, but rarely fever. When the ulcer spreads with great rapidity and becomes deeper as well as larger in surface-area, it is called "phagedenic." The formation of sloughs indicates that tissue-death is going on so rapidly that the dead portions have not time to break down and be cast off. Limited stasis produces molecular death; more extensive stasis, a slough. If a chronic ulcer becomes acute, the granulations are destroyed.

Treatment.—In treating an acute ulcer of the leg, give a dose of blue mass or calomel, followed in eight or ten hours by a saline (ʒij each of Rochelle and Epsom salt), and order light diet. Deny stimulants except in a case of diphtheritic ulcer. Administer opium if pain is severe. Spray the ulcer with hydrogen peroxid, use the scissors and forceps to get rid of sloughs, and after sloughs are removed wash the ulcer with corrosive sublimate solution (1 : 1000), or paint it with pure carbolic acid. Paint the skin adjacent to the ulcer with equal parts of tincture of iodin and alcohol. Dress with hot antiseptic fomentations. Apply a bandage from the toes to well above the ulcer. Insist on the patient remaining in bed with the leg slightly elevated. Change the dressings before they cool and always as soon as they are saturated with discharge. Every day paint iodin on the parts about the ulcer.

Many cases do very well after antiseptization, and dusting the ulcer with iodoform, lead-water and laudanum being applied to the inflamed parts around the ulcer; but in a bad case hot antiseptic fomentations, compression, and elevation are more useful until sloughs separate. If the discharge is offensive, apply acetanilid, aristol, or iodoform, or use gr. iij of chloral to every ℥j of water, before applying hot fomentations or ordinary antiseptic dressing. A 25 per cent. oint-

ment of ichthyol is very useful applied around the ulcer. If sloughs continue to form, touch with a 1 : 8 solution of acid nitrate of mercury or with a solution of pure carbolic acid, and reapply antiseptic fomentations. If an ulcer continues to spread, clean it with peroxid of hydrogen, dry with absorbent cotton, touch with nitrate-of-mercury solution (1 : 8), and apply an antiseptic fomentation. Repeat the application of nitrate of mercury every day until the ulcer ceases to extend and granulations begin to form. When granulations begin to form the moist hot dressings are no longer necessary, and dry aseptic or antiseptic dressings can be used.

In an ulcer covered with a great mass of aplastic lymph touch daily with a solution of silver nitrate (gr. xl to ℥j) or with acid nitrate of mercury (1 : 15), and dress with iodoform and antiseptic fomentations. Give internally tonics, stimulants, and good food. In any case, when granulations form, dress antiseptically with dry dressings, or employ a non-irritant ointment, such as cosmolin. If granulations form slowly, touch them every day with a solution of silver nitrate (gr. x to ℥j) and dress antiseptically, or apply a stimulating ointment (resin cerate or ʒj of ung. hydrarg. nitratis to ʒvij of ung. petrolii, or an ointment of copper sulphate, gr. iij to ℥j), or dress with gauze soaked in a solution of 3 drops of nitric acid to ℥j of gum Arabic.

Chronic ulcer of the leg is characterized by low action and slow progress. It may be chronic from the start, or it may result from acute ulcer. More usually it is found as a solitary ulcer two inches above the internal malleolus. Syphilitic ulcers often occur in a group, are usually crescentic, and are frequent upon the front of the knee. A tubercular ulcer may have no granulations, but is usually covered with pale edematous granulations, which signify the existence of a tendency to venous stasis. The edges of the tubercular ulcer are undermined and irregular, the parts about it are livid and tender, and the discharge is thin and scanty (p. 194). An ordinary chronic ulcer is circular or oval, and is surrounded by congested, discolored, and indurated skin, this induration being due to fibrous tissue, and there is often eczema or a brown pigmentation of the neighboring skin. The floor of the ulcer is uneven, and usually is covered with granulations, each of which is red and the size of a pin-point, but which may be exuberant or edematous. If granulations are absent, the ulcer has the appearance of a piece of liver, or is smooth and glazed. The edges are thick, turned

out, and not sensitive to the touch. Occasionally, but rarely, they are thin and undermined. Some ulcers are indurated and adherent; this adhesion to the deeper structures prevents healing by antagonizing contraction. An ulcer may fail to heal because of severe infection; because of want of rest; because of absence of granulations, the result of deficient blood-supply; because of edematous granulations; because of exuberant granulations; because of adhesion to deep structures, and because of some constitutional disease.

Treatment.—In treating a chronic ulcer, give a saline cathartic every day or so. Treat any existing diathesis. Insist on rest and, if possible, elevation. Asepticize the ulcer. Draw blood by shallow scarifications of the bottom and edges of the ulcer and the skin about it. If the ulcer is adherent to deeper structures, make incisions like those shown in Fig. 45, each cut going through the deep fascia. These incisions, besides permitting contraction, allow granulations to sprout in the cuts and absorb exudate. After incision keep the part elevated and dressed antiseptically for two days. In two days after scarification or incision scrape the ulcer with a curet until sound tissue is reached. Use hot antiseptic fomentations for two days more, then paint around the ulcer with tincture of iodin and alcohol (1 : 3), dress the parts about the ulcer with ichthyol ointment, and dress the ulcer antiseptically or with sterile gauze. In a day or so the use of ichthyol can be discontinued and the ulcer can be dressed antiseptically with sterile gauze, normal salt solution, boric acid, bichlorid of palladium, chlorin-water, a solution of permanganate of potassium, sulphur, glutol, protonuclein, or bovinin. Glutol (formalin-gelatin) is very useful in some cases and so is protonuclein. When healing begins, treat as outlined for healing acute ulcer (p. 143).

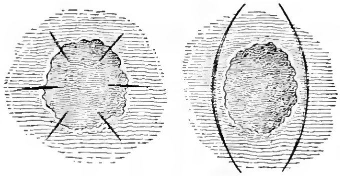


Fig. 45.—Incisions for adherent ulcer.

Complications.—Remove by scissors and forceps any badly damaged tissue. Take out dead bone; slit sinuses; trim overhanging edges. Treat eczema by attention to the bowels and stomach, and locally by washing with ethereal soap and by the use of powdered oxid of zinc or borated talcum, the leg being wrapped in cotton. In eczema, avoid ordinary soap, grease, and ointment. Varicose veins demand

either ligation at several points, excision, circumcision by Schede's method (p. 348), or the continued use of a flannel roller- or a Martin rubber-bandage. Never operate on varicose veins if phlebitis exists. Inflammation is met by rest, elevation, painting the neighboring parts with dilute iodin, and applying about the ulcer ichthyol ointment, For calloused edges, blister, employ radiating incisions, or cut the edges away. Ordinary thick edges should be strapped. In strapping use adhesive plaster and do not completely encircle the limb (Fig. 46). Edematous granulations require dry dress-

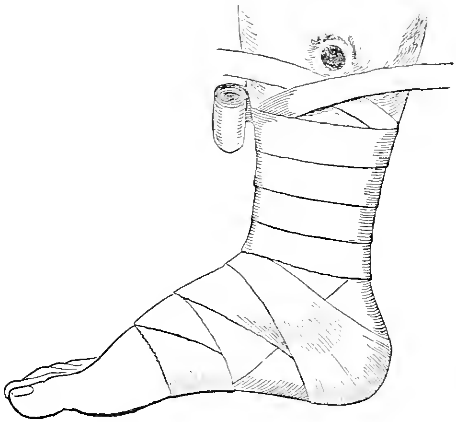


Fig. 46.—Strapping of ulcer of leg (after Liston).

ings and pressure by a flannel-bandage, a rubber-bandage, or adhesive plaster. When the parts are adherent the ulcer is immovable, being firmly anchored to structures beneath it. In such a condition completely or partly surround the sore with a cut through the deep fascia (Fig. 45). This cut sets the ulcer free from its anchorage and permits it to contract. If the bottom of the ulcer is foul, dry it and touch with a solution of acid nitrate of mercury (1 : 8) or with crystals of pure carbolic acid. Repeat this every third day and dress with hot antiseptic fomentations until granulations appear. Superfluous granulations (proud flesh) should be cut away with scissors, scraped away, or burned down with a strong solution of silver nitrate or with the solid stick of lunar caustic. Absence of granulations or scantiness of granulations means deficiency of blood-supply. The surgeon endeavors to bring more blood to the part, and to do this induces inflammation. The usual method of procedure is to apply daily

to the sore a solution of nitrate of silver (10 to 15 grains to the ounce). In obstinate cases blister the ulcer or scrape it, or paint it with tincture of iodin, or apply pure carbolic acid, or touch it with the actual cautery.

Irritable ulcer is due to exposure of a nerve and destruction of its sheath. Find with a probe the painful granulation and divide it with a tenotome, or curet the ulcer or burn it with the solid stick of silver nitrate. If healing entirely fails, skin-graft. Among the methods of skin-grafting are—(1) Reverdin's, (2) Thiersch's, and (3) Krause's. (See Plastic Surgery.)

When a man having an ulcer must go out and about, use a firmly applied roller-, or, better still, a Martin bandage. This bandage, which is made of red rubber, limits the amount of arterial blood going to the ulcer and favors venous flow from the sore and its neighborhood. The bandage should be used as follows: before getting out of bed spray the sore with hydrogen peroxid by means of an atomizer, dry off the froth with absorbent cotton, wash the leg with soap and water, dry it with a towel, dust the extremity with borated talcum powder, and put on the bandage—all of which should be done before putting a foot to the floor. At night, after getting on the bed, remove the bandage, wash it with soap and water, dry it with a towel, hang it unrolled over a chair, and again cleanse the leg and ulcer. If these rules are not strictly observed, the Martin bandage will produce pain, suppuration, and eczema of the leg.

Tubercular Ulcers (see p. 194).

Syphilitic Ulcers (see p. 250).

A **healthy ulcer** is covered with small, bright-red granulations which do not bleed on touching, are painless, and grow rapidly. The edges are soft and show the opalescent blue line of proliferating epithelium. The sore is movable, the discharge is purulent and yellow, and the parts about are not inflamed.

Various Ulcers.—The **fungous** or **exuberant ulcer** is produced by interference with the return of venous blood from the part, and it is specially common after burns and other injuries when cicatricial contraction causes venous obstruction. The granulations are large, deep red in color, bleed when touched, form rapidly, and mount above the level of the skin. The discharge from a fungous ulcer is profuse, thin, and bloody. In the treatment of such an ulcer venous return must be favored by bandaging and by elevation of the part. If the edges are very thick, divide them in a num-

ber of places. The superfluous granulations should be burnt off with lunar caustic or cut off. Strapping with adhesive plaster or the use of a rubber-bandage does good. The sore can be dressed with europhen, aristol, or dry aseptic gauze.

A **varicose ulcer** is an ulcer complicated by varicose veins. It is usually single, is oval, round, or irregular in outline, and is most often seen above the inner malleolus. Its edges are thick, everted, and swollen. The swelling is largely due to edema, and is found to pit on pressure. The edges are not undermined, but slope gently to the floor of the ulcer. The floor is usually covered with rather large granulations which bleed freely on touching. In a varicose ulcer the destruction of tissue often begins at the margin of a congested area and advances toward the center. Such an ulcer is usually surrounded by eczema. To aid the healing of a varicose ulcer it is first of all necessary to favor the return of venous blood from the part by position and bandaging. Martin's bandage is very useful. It may be necessary to operate on the veins.

Erethistic, irritable, or **painful ulcers,** which are very sensitive, are due to the exposure of nerve-filaments and destruction of their sheaths. They are especially found near the ankle, over the tibia, in the anus (fissure), or in the matrix of the nail (ingrowing nail). Curet an erethistic ulcer, and touch with pure carbolic acid or with the solid stick of silver nitrate. Chloral, gr. xx to the ounce, allays the pain; so do cocain and eucain for a time.

The **indolent ulcer** shows no tendency to heal. In such an ulcer there is usually venous congestion from varicose veins or from cardiac weakness. A great mass of scar-tissue forms at the base and edges, which fastens the ulcer to bone or fascia, so that the edges cannot contract. Healthy granulations cease to form. Varicose ulcers are apt to become indolent. The edges of such an ulcer are thick, smooth, immovable, and free from tenderness. Granulations are entirely absent or there are seen here and there a few unhealthy granulations. The discharge is thin, seropurulent, and offensive. The parts about the ulcer are congested and pigmented. The pigmentation is due to the fact that in an area of chronic congestion numbers of red blood-cells have been disintegrated. Such an ulcer is treated by making incisions to loosen the base and edges, so that contraction can take place, correcting the venous congestion by means of position, the use of compression and cardiac stimulants,

and the employment of stimulating applications to the ulcer in order to increase the supply of arterial blood.

The **callous ulcer** is the most chronic form of indolent ulcer and is sunken deeply below the level of the skin. Its border is hard and knobby. Its floor shows no granulations, and is either smooth and glistening or foul and liver-colored. The discharge is thin and scanty, and the ulcer varies little in appearance from week to week or even from month to month. The treatment consists in scraping and cauterization of the ulcer; cutting through the edges by radiating incisions; application of antiseptic dressings and a firm bandage. In some cases strap the ulcer. In severe cases extirpate the ulcer and apply skin-grafts.

The **hemorrhagic ulcer** bleeds easily and profusely. Pressure must be applied, and it is sometimes necessary to cut away or burn away the granulations.

Phagedenic Ulcer.—The phagedenic ulcer results from the profound microbic infection of tissues debilitated by local or constitutional disease, and is commonly venereal. This ulcer has no granulations and is covered with sloughs; its edges are thin and undermined, and it spreads rapidly in all directions. It requires the use of strong caustics or Paquelin's cautery, followed by iodoform dressing and antiseptic fomentations. Internally use tonics and stimulants.

The **edematous ulcer** may result from impediment to the venous return or, as Nancrede points out, may be produced by the persistent use of poultices or wet dressings upon any ulcer.[1] It is most often met with in tubercular processes and is occasionally seen when varicose veins exist. The granulations are large and pale, and are apt to bend over like unsupported vines. The discharge is profuse and seropurulent. The edges are softened and desquamating. An edematous ulcer requires dry dressings, stimulation, and compression.

A **rodent** or **Jacob's ulcer** is a superficial epithelioma developing from sebaceous glands, sweat-glands, or hair-follicles. It requires scraping and cauterization, or, what is better, excision.

Marjolin's ulcer is an epithelioma arising from a chronic ulcer.

Decubitus, or **bed-sore,** is due to pressure upon an area of feeble circulation (p. 164). It is really a condition of gangrene.

Neuroparalytic or **trophic ulcer** is due to impairment of the trophic centers in the cord.

[1] *Principles of Surgery.*

The **perforating ulcer**, as it was named by Vesigne, commonly affects the metatarsophalangeal joint or the pulp of the great toe about a corn. The parts about the corn inflame, and pus forms and reaches into the bone. A sinus evacuates the pus by the side of the corn. As this ulcer may be present in anesthetic leprosy, in a paralyzed limb, and tabes dorsalis, and as the part on which it occurs is apt to be sweaty, cold, and more or less anesthetic, and as the sore may be hereditary, it is usually set down as trophic in origin. Treatment of a perforating ulcer consists, according to Treves, in going to bed and poulticing. Every time a poultice is removed the raised epithelium around the ulcer is cut away and then the poultice is reapplied. In about two weeks an ulcer remains surrounded by healthy tissue. Treves treats this sore with glycerin made to a creamy consistency with salicylic acid, to each ounce of which ♏x of carbolic acid have been added. He directs the patient to wear during the rest of his life some form of bunion-plaster to keep off pressure. Nerve-stretching has been recommended as the proper treatment for perforating ulcer. If in a perforating ulcer the bone is diseased, it must be removed. This ulcer tends to recur in the same spot or in adjacent parts, and it may be necessary to amputate the toe or the foot.

The **scorbutic ulcer** is covered with a dark-brown crust, beneath which are pale and bleeding granulations. The parts adjacent are of a violet color.

Epitheliomatous, sarcomatous, tubercular, and syphilitic ulcers are considered under these respective diseases.

Fistula.—A fistula is an abnormal communication between the surface and an internal part of the body, or between two natural cavities or canals. The first form is seen in a rectal fistula, a urethral fistula, or a biliary fistula; and the second form is seen in a vesicovaginal fistula. Fistulæ may result from congenital defect, as when there is failure in the closure of the branchial clefts, and can arise from sloughing, traumatism, and suppuration. Fistulæ are named from their situation and communications.

A **sinus** is a tortuous track opening usually upon a free surface and leading down into the cavity of an imperfectly healed abscess. A sinus may be an unhealed portion of a wound. Many sinuses are due to pus burrowing subcutaneously. A sinus fails to heal because of the presence of some irritant fluid, as saliva, urine, or bile; because of the existence of a foreign body, as dead bone, a bit of wood, a bullet, a septic ligature, etc.; or because of rigidity of the

sinus-walls, which rigidity will not permit collapse. Sinuses may be maintained by want of rest (muscular movements) and general ill-health. The walls of a tubercular sinus are lined with a material identical with the pyogenic membrane of a cold abscess.

Treatment.—In treating a fistula or a sinus, remove any foreign body, lay the channel open, curet, brush with pure carbolic acid, and pack with iodoform gauze. In obstinate cases entirely extirpate the fibrous walls, sew the deeper parts of the wound with buried catgut sutures, and approximate the skin-surfaces with interrupted sutures of silkworm-gut. Fresh air is a necessity, and nutritious food and tonics must be ordered.

VIII. MORTIFICATION, GANGRENE, OR SPHACELUS.

Mortification, or gangrene, is death in mass of a portion of the living body—the dead portions being large enough to be visible—in contrast to ulceration, or molecular death, in which the dead particles have been liquefied, cannot be seen, and are cast away. When all the tissues of a part are dead the process is spoken of as sphacelous. Gangrene is in reality a form of necrosis, but clinically the term necrosis is restricted to molar death of bone or to death of parts below the surface *en masse*. In gangrene a portion of tissue dies because of anemia, and the dead portions may either desiccate or putrefy. Gangrene may be due to tissue-injury, either chemical or mechanical, to heat or cold, to failure of the general health, to circulatory obstruction, to nerve-disorder, the nerves involved being the vasomotor or possibly the trophic, or to microbic infection. A microbic poison can directly destroy tissues. It can indirectly destroy them by causing such inflammation that the products obstruct the circulation, but gangrene can occur when no bacteria are present. The essential cause of gangrene is that the tissues are cut off from a due supply of nourishment, and cell-nutrition is no longer possible. In other words, the essential cause of gangrene is the cutting off of arterial blood. Nancrede says: "Indeed, except when the traumatism physically disintegrates tissues, as a stone is reduced to powder, heat or strong acids physically destroy structure, or cold suspends cellular nutrition so long that when this nutrition becomes a physical possibility vital metabolism cannot be resumed, gangrene always results from total deprivation of pabulum."[1]

[1] *Principles of Surgery.*

Classification.—Gangrene is divided into the following three great groups:

(1) **Dry gangrene,** which is due to circulatory interference, the arterial supply being decreased or cut off. The tissues dry and mummify.

(2) **Moist gangrene,** which is due to interference not only with arterial ingress, but also with venous return or capillary circulation, the dead parts remaining moist.

(3) **Microbic gangrene,** arising from virulent bacteria. In this form the bacterial process causes the gangrene, and is not merely associated with it.

The above classification, if unqualified, suggests erroneous ideas. It indicates that there is an essential difference between dry gangrene and moist gangrene, which is not the case. If when gangrene begins the tissues are free from fluid, the patient develops dry gangrene; if they are full of fluid, he develops moist gangrene. If the arterial supply is gradually cut off, the tissues are sure to be free from fluid, and the gangrene will certainly be of the dry form. If arterial blood is suddenly cut off, the gangrene may be dry or moist, according as to whether the tissues are or are not drained of fluid. When gangrene results from inflammation, strangulation, and infection, it is certain to be of the moist variety, because the tissues are sure to be filled with fluid.

Nancrede says, in his very valuable work on the *Principles of Surgery:* "Yet, let accidental inflammation have preceded the final blocking of an artery, or let ligation of the main artery cause gangrene because the collateral circulation cannot become developed, and if an aneurysmal sac is so situated as to interfere with a free return of venous blood and lymph, this anemic gangrene will in both instances prove moist and not dry."

There are many gangrenous processes which belong under one or other of the above heads, namely: *congenital* gangrene, a rare form existing at birth; *constitutional* gangrene, arising from a constitutional cause, as diabetes; *cutaneous* gangrene, which is limited to skin and subcutaneous tissue, as in phlegmonous erysipelas; *gaseous* or *emphysematous* gangrene, in which the subcutaneous tissues are filled with putrefactive gases and crackle on pressure; *hospital* gangrene, which is defined by Foster as specific serpiginous necrosis, the tissues being pulpefied: some consider it a traumatic diphtheria; *cold* gangrene, a form in which the parts are entirely dead (sphacelus); *hot* gangrene, which is associated with inflammation, as shown by heat; *dermatitis gan-*

grænosa infantum, or the multiple cachectic gangrene of Simon; *idiopathic* gangrene, which has no ascertainable cause; *mixed*, which is partly dry and partly moist; *primary*, in which the death of the part is direct, as from a burn; *secondary*, which follows an acute inflammation; *multiple*, as gangrenous herpes zoster; *diabetic* or *glycemic gangrene*, which arises during the existence of diabetes; *gangrenous ecthyma*, a gangrenous condition of ecthyma ulcers; *pressure*, which is due to long compression; *purpuric* or *scorbutic*, which is due to scurvy; *Raynaud's* or *idiopathic symmetrical*, which is due to vascular spasm from nerve-disorder; *senile*, the dry gangrene of the aged; *venous* or *static*, which is due to obstruction of circulation, as in a strangulated hernia; *trophic*, which is due to nutritive failure by reason of disorder of the trophic nerves or centers; *thrombotic*, which is due to thrombus; *embolic*, which is due to embolus; and *decubitus*, *decubital* gangrene, or bed-sores due to pressure.

Dry gangrene arises from deficiency of arterial blood. For this reason Nancrede calls it anemic gangrene.

This form of gangrene is far more apt to result from the gradual than from the sudden cutting off of the supply of arterial blood, and is more common if the blood-vessels are atheromatous than if they are healthy; but even in a person with healthy arteries gangrene will ensue upon blocking of the main artery, if the collaterals fail to supply the part with blood. This form of gangrene can occur after laceration, ligation, or the lodgement of a thrombus in the main artery of a limb; but in such cases considerable fluid usually remains in the tissues and the gangrene is apt to be moist rather than dry.

Obstruction due to thrombus is not unusual in the diseased arteries of the aged, and such obstruction generally results in dry gangrene. An embolus may cause dry gangrene in rare instances. If it does so, it is probable that the blocking was not at once complete. When an embolus lodges in an artery and causes dry gangrene, the case runs the following course: sudden severe pain at the seat of impaction, and also tenderness; pulsation above, but not below, this point, after obstruction has become complete; the limb below the obstruction is blanched, cold, and anesthetic; within forty-eight hours, as a rule, the area of gangrene is widespread and clearly evident; the limb becomes reddish, greenish, blue, and then black; the skin becomes shrivelled and its outer layer stony or like horn because of evaporation. The entire part may become dry; but usually there are spots where

some fluid remains, and these spots are soft and moist, and the dead tissue, where it joins the living, is sure to be moist. The moist areas become foul and putrid, but the dry spots do not. In dry gangrene, at the point of contact of the dead and living tissues, inflammation arises in the latter structures, a bright-red line forms, and exudation and ulceration take place. This line of ulceration in the sound tissues is called the "line of demarcation." It is Nature's effort at amputation, and in time may get rid of a large portion of a limb, and then heal as any other ulcer. A line of demarcation rarely causes hemorrhage, because it ulcerates through a vessel only after inflammation has caused occlusion by thrombosis. In dry gangrene from arterial obstruction there are gastro-intestinal derangement and some fever. The gangrene does not extend up to the point of obstruction, but only to a region in which the anastomotic circulation is sufficiently active to permit of the formation of a line of demarcation. Below this point inflammatory stasis arises, but before this can go on to ulceration the parts die. In cases where the arterial obstruction is sudden and complete the limb swells decidedly. This is due to the sudden loss of *vis a tergo* in the arterial system, venous reflux occurring and fluids transuding. In such a case the tissues contain fluid and putrefy, and the process, though due to the cutting off of the arterial circulation, is moist gangrene. Dry gangrene attacks the leg more often than the arm. Thrombus in an artery rarely causes gangrene except in the aged, as the collateral circulation has time to adjust itself; but gangrene may follow thrombus, and when it does it comes on more slowly than does gangrene from embolus, and is certain to be of the dry form.

Treatment of Non-senile Dry Gangrene.—When injury of a healthy artery causes us to fear dry gangrene the patient should be placed in bed and the part elevated a little, kept wrapped in cotton-wool and warmed with hot bottles or hot water-bags. The dying part is dressed antiseptically, and the surgeon sees to it that the patient gets plenty of sleep and nourishment. It is advisable to give tonics and stimulants. Wait for a line of demarcation and amputate well above it.

Senile gangrene, chronic gangrene, Pott's gangrene (Fig. 47), is a form of gangrene due to feeble action of the heart plus obliterating endarteritis or atheroma of peripheral vessels. The vessels do not properly carry blood, and may at any time be occluded by thrombosis. In a drunkard, or

in a victim of syphilis or tubercle, the changes supposed to characterize old age may appear while a man is young in years. It was long ago said, with truth, "a man is as old as

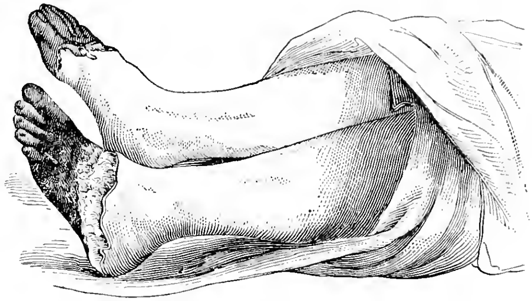


FIG. 47.—Senile gangrene of the feet (Gross).

his arteries." Senile gangrene most often occurs in a toe or the foot.

Symptoms.—A man whose vessels are in the state above indicated is generally in feeble health and has a fatty heart and an arcus senilis (a red or white line of fatty degeneration around the cornea). His toes and feet feel cold and numb, and they "go to sleep" very easily, and he suffers from cramp of the legs and feet. He is dyspeptic and short of breath, and his urine is frequently albuminous. The arteries are felt as rigid tubes, like pipe-stems. He is in danger of edema of the lungs and of dry gangrene of the toes. A slight injury of a toe, for instance, cutting a corn too close, will produce extensive inflammatory stasis followed by thrombosis, which completely cuts off the blood-supply and causes gangrene of the part. Gangrene is usually announced by the appearance of a purple and anesthetic spot, followed by a vesicle which ruptures and liberates a small amount of bloody serum and exposes a dry floor. In the parts about the gangrenous area there is often burning pain. The tissues immediately adjacent to the dead spot are in a condition of edema and stasis, the parts being purple, the color disappearing slowly under pressure and returning slowly when pressure is removed. The parts a little further removed are edematous and hyperemic, the color disappearing rapidly on pressure and returning rapidly when pressure is removed. The dead parts do not putrefy at all or do so but slightly, hence the odor is never very offensive and is usually trivial. They are anesthetic, hard, leathery, and wrinkled, and

resemble a varnished anatomical specimen or the extremity of a mummy (hence the term mummification). Before the line of demarcation forms there is burning pain; after it forms pain is rarely present. If embolism or thrombus in a diseased vessel caused the gangrene, the pain is severe. In senile gangrene the periphery is always dry, the part nearer the body being generally somewhat moist. The process may be very limited or it may spread up to the knee. As it spreads the area of hyperemia advances at the margin, the area of stasis follows, and the zone of gangrene becomes more extensive. When tissues are reached the blood-supply of which is sufficiently good to permit of inflammation, Nature tries to limit the gangrene by the formation of a line of demarcation. A line of demarcation may begin, but prove abortive, the tissue mortifying above it. This proves that tissue near the line is in a state of low vitality. When a limited area is gangrenous constitutional symptoms are trivial or absent, but when a large area is involved the fever of septic absorption exists. Death may ensue from exhaustion caused by sleeplessness and pain, from septic absorption, or from embolism of internal organs. In many cases of senile gangrene thrombosis arises in the superficial femoral artery or its branches (Heidenhain), an observation it is important to bear in mind when amputating.

Prevention of Senile Gangrene in the Predisposed.—We should caution such a patient to avoid injuring his toes and feet. Cutting his corns carelessly is highly dangerous, and any wound, however slight, requires rest and antiseptic dressing. The victim of general atheroma must wear woollen stockings, put a hot-water bag to his feet on cold nights, and attend to his general health. A little whiskey after each meal is indicated, and occasional courses of nitroglycerin are desirable.

Treatment of Senile Gangrene.—When gangrene occurs, if it is limited to one toe or a portion of several toes, if it is a first attack, if there is no fever or exhausting diarrhea, if there is no tendency to pulmonary congestion, if the appetite is fair and sleep refreshing, it is best to avoid radical interference. Await the formation of a line of demarcation. While awaiting the line of demarcation dress the part antiseptically and raise the foot several inches from the bed; apply warmth, give the patient nourishing diet, stimulants, and tonics; see to it that he sleeps, and during the spread of the gangrene watch for fever, diarrhea, pulmonary congestion, and kidney-failure. When a line of demarcation forms, dress

with antiseptic fomentations and iodoform, and every day pick away dead bits with the scissors and forceps. In many cases healing will occur; but even when the parts heal the patient will always be in deadly peril of another attack. If the gangrene shows a tendency to spread, if it involves more than a portion of several toes, if it is not a first attack, if there is sleeplessness, fever, exhausting diarrhea, absent appetite, or a strong tendency to pulmonary congestion, do not delay, but at once amputate high up. If the gangrene shows no tendency to limit itself, or if the patient develops sepsis or exhaustion, at once amputate high up. The best point at which to amputate is above the knee, so that the deep femoral artery, which rarely becomes atheromatous, will nourish the flap. Never amputate below the tubercle of the tibia. Some operators disarticulate at the knee-joint. Heidenhain affirms that so long as the gangrene is limited to one or two toes we should merely treat it antiseptically, elevate the limb, and wait for the dead part to be cast off spontaneously; if, however, it extends to the dorsum or sole of the foot, we should amputate at once above the knee. He further states that gangrene of the flaps almost always occurs in amputation below the knee, and high amputation is indicated in advancing gangrene with or without fever.[1] When amputation has been performed and the Esmarch band has been removed and no arterial bleeding takes place from the superficial femoral artery, a clot is lodged in that vessel. If such a condition exist, insert into the artery a fine rubber catheter or a filiform bougie and break up the clot. When blood flows we are sure that the clot has been washed out.[2]

In **moist** or **acute gangrene** (Fig. 48) the dead part remains moist and putrefies As Nancrede points out, there are two forms of moist gangrene: "that limited to the areas actually killed by a traumatism, with some surrounding tissue which dies," and "that which tends to spread widely, this latter usually being caused by specific micro-organisms, an intense, widespread, pyogenic inflammation resulting, involving the subcutaneous and intermuscular cellular planes, by strangulation of the vessels of which all blood-supply to the remaining soft parts is destroyed."[3] In a case of gangrene the parts remain moist, either because the main artery has become suddenly blocked, and the tissue-fluids are unable to flow out of the limb, or because the main vein

[1] *Deutsche medicinische Wochenschrift*, 1891, p. 1087.

[2] Severeanu. See Mancozet's report before the second Pan-American Medical Congress.

[3] Nancrede's *Principles of Surgery*.

is blocked. It may arise in a limb after ligation, obstruction, or destruction of its main artery, main vein, or both; after long constriction, as by a tight bandage; after crushes and lacerated wounds; and after thrombosis of the vein. Moist gangrene may follow acute inflammation, or may be due to

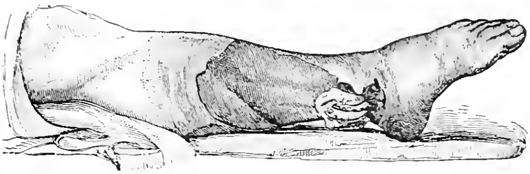


Fig. 48.—Acute gangrene (Gross).

local constriction (strangulated hernia), crushing, chemical irritants, heat, and cold.

Moist gangrene of a limb is seen typically when both vein and artery are constricted, damaged, or destroyed. The leg swells greatly and is pulseless below the obstruction; the skin, at first pale, cold, and anesthetic, becomes livid, mottled, or purple or greenish, and is raised into blebs which contain a reddish or brown fluid. "These blebs, being caused by the accumulation of serum beneath epithelium which has lost its vital connection with the derm, can be slipped around upon the surrounding true skin, the epithelium readily separating for long distances around, as in a cadaver" (Nancrede). The extremity swells enormously, there is pain at the seat of obstruction, and sapremic symptoms quickly develop. The bullæ break and disclose the brown derm and sometimes the deeper structures, which are swollen and edematous. The fetor is horrible. The saprophytic organisms may lead to the formation of gas, and if the gas is retained in the tissues pressure with the finger will develop a sensation of crackling. This condition is known as emphysema. A line of demarcation soon forms.

Moist gangrene from inflammation is due to pressure of the exudate cutting off the blood-supply, or to loss of blood-circulation because of microbic involvement of vessels and clotting of blood. It occurs in phlegmonous erysipelas. When an inflammation is about to terminate in gangrene all the signs of inflammation, local and constitutional, increase; when gangrene occurs they cease, bullæ and emphysema are noted, with great swelling and all the other symptoms of molar death. The sudden cessation of pain is very suggestive

of gangrene. The constitutional symptoms are those of suppurative fever and sapremia, or possibly of septic infection.

When a wound becomes gangrenous the surface looks like yellow or gray tow, the discharge becomes profuse and very fetid, and the parts about swell enormously and gradually become gangrenous.

Treatment of Moist Gangrene.—In extensive moist gangrene of a limb wait for a line of demarcation, and amputate clear of and above it. While waiting for the line to form dress the dead parts antiseptically, wrap the extremity in cotton, apply heat, and slightly elevate the limb. Give opium, tonics, nourishing food, and stimulants. In inflammatory gangrene relieve tension by incisions and then cut away the dead parts, brush the raw surface with pure carbolic acid, dust with iodoform, and dress with hot antiseptic fomentations. Stimulate freely and feed well. A gangrenous wound is treated as pointed out in the section on Sloughing.

Acute microbic gangrene, fulminating gangrene, gangrenous emphysema, gangrene foudroyante, or **traumatic spreading gangrene,** results from a virulent infection of a wound. The condition may be due to a mixed infection with virulent streptococci and organisms of putrefaction; or to infection with the bacilli of malignant edema, and putrefactive organisms. Some cases are due to the bacillus of malignant edema alone; some are due to the bacillus aërogenes capsulatus of Welch and Flexner. The injury is usually severe—often a crush which destroys the main artery and renders an anastomotic circulation impossible. In such severe accidents the limb is much swollen and the pulse below the seat of injury is imperceptible, and the surgeon is often at this time uncertain whether to amputate at once or wait. In some cases traumatic spreading gangrene arises after trivial injuries. This form of gangrene is commonest after compound fractures, and begins within forty-eight hours of the accident. The extremity becomes enormously swollen from edema. The gangrene does not begin at the periphery, as does ordinary moist gangrene, but at the wound-edges, which turn red, green, and finally black; the extremity soon undergoes a like change and becomes mortified. The skin peels off, emphysematous crackling, due to gas formed and retained in the tissues, can be detected over large areas, and the extremity becomes anesthetic and pulpy. The gangrene spreads up and down from the wound, and red lines, due to lymphangitis, run from above the wound. The adjacent lymph-glands swell, and in thirty-six hours the gangrene

may involve an entire limb. No line of demarcation forms. The system is soon overwhelmed with ptomaïns, and the patient suffers from septic intoxication, and often passes into profound collapse with subnormal temperature. Traumatic spreading gangrene must not be confused with erysipelas. In erysipelas the color is red, pressure instantly drives it out, and on the release of pressure it at once returns. In early gangrene the color is purple, pressure fails to drive it out at all or only does so very slowly, and if the surface is blanched by pressure, on the release of pressure the color crawls slowly back.

Treatment.—In treating traumatic spreading gangrene a line of demarcation need not be waited for, as none can form. Amputation should at once be performed high up, the flaps are brushed with pure carbolic acid, and stimulants must be given in large amount.

Hospital gangrene or sloughing phagedena is a disease that has practically disappeared from civilized communities. It formerly occurred in crowded, ill-ventilated hospitals. Some consider it traumatic diphtheria. Koch thinks it is due to streptococci. Jonathan Hutchinson says, "hospital gangrene is set up by admitting to the wards a case of syphilitic phagedena." It may show itself as a diphtheritic condition of a wound, as a process in which sloughs which look like masses of tow form, or as a phagedenic ulceration. The surrounding parts are inflamed and painful, and buboes form in adjacent lymphatic glands. The system passes into a low septic state.

Treatment.—In treating hospital gangrene ether should be given, the large sloughs removed with scissors and forceps, the parts dried with cotton and cauterized with bromin. The surgeon should take a tumblerful of water and into it pour the bromin, which will fall to the bottom of the glass. The drug can be drawn up with a syringe and injected into the depths of the wound. The wound should be plentifully sprinkled with iodoform and dressed with hot antiseptic fomentations. When the sloughs separate the sore can be treated as an ordinary ulcer. The constitutional treatment is that employed for sepsis. If a limb is hopelessly damaged by this form of gangrene, wait for a line of demarcation and amputate.

Special Forms of Gangrene.—**Symmetrical** or **Raynaud's gangrene** arises in severe cases of Raynaud's disease. It is a dry gangrene. Raynaud's disease, a vasomotor neurosis seen in children and young adults, is characterized by

attacks of cold, dead bloodlessness in the fingers or toes as a result of exposure to cold or of emotional excitement (local syncope). In the more severe cases there are capillary congestion and livid swelling (local asphyxia). A chilblain is an area of local asphyxia. In Raynaud's disease the patient complains of pain, tingling, and stiffness in the affected parts. Attacks of Raynaud's disease occur again and again, are often accompanied by hemoglobinuria, and may never eventuate in gangrene. The pathology is uncertain. Local syncope is thought to be due to vascular spasm, and local asphyxia to some contraction of the arterioles, with dilatation of the capillaries and venules. It is after local asphyxia that gangrene may appear.

Raynaud's gangrene is most commonly met with upon the ends of the fingers or the toes, but it may attack the lobes of the ears, the tip of the nose, or the skin of the arms or the legs. Sometimes the disease is seen upon the trunk. When gangrene is about to occur the local asphyxia at that point deepens, anesthesia becomes complete, and the part blackens and feels cold to the touch. The epidermis raises into blebs, which rupture and expose dry surfaces. A line of demarcation forms, and the necrosed area is removed as a slough. Widespread gangrene from Raynaud's disease is rare; there is not often a large area involved—rather a small superficial portion.

Treatment of Raynaud's Disease.—When attacks of Raynaud's disease are so severe as to threaten gangrene, put the patient to bed; if the feet are affected, elevate the legs slightly, wrap the extremities in cotton-wool, and apply heat. If the hands are affected, wrap them in cotton-wool, elevate them slightly, and apply heat. Massage is useful. When gangrene occurs, dress the part antiseptically until a line of demarcation forms, and then remove the dead parts by scissors, forceps, and antiseptic fomentations. If amputation becomes necessary, which will rarely be the case, wait for a line of demarcation.

Diabetic gangrene resembles in many points senile gangrene, but the dead portions remain somewhat moist and putrefy. Some attribute it directly to sugar in the blood. Some think the tissues are simply less resistant to infection. Many hold that it is of neurotic origin. Heidelhain believes that it is due to arterial sclerosis. Diabetic gangrene is most usually met with upon the feet and legs of elderly people, but it may arise at any age and may attack the genital organs, thigh, lung, buttock, eye, back, finger, or neck.

It may affect only a single area, may attack several areas, or may be symmetrical. It may arise in any stage of diabetes from the earliest to the latest. It may begin as a perforating ulcer. As in senile gangrene, a trivial injury is apt to be the exciting cause, but it may arise without any antecedent injury. When the gangrene follows a traumatism there are no prodromic symptoms. When it arises spontaneously in the skin it is often preceded by pain of a neuralgic nature and attacks of "livid or violaceous discoloration of the skin, with lowered surface-temperature and sometimes loss of sensation" (Elliot). Diabetic gangrene is often superficial, but may become deep if it follows an injury or ulcer. The gangrenous area is somewhat moist as a rule, but may be dry. The parts about are livid and may be covered with vesicles. It spreads slowly, but more rapidly than senile gangrene. There is little tendency to the formation of any line of demarcation, although occasionally spontaneous healing occurs. Surgeons have become shy of amputating in such cases, but the experience of Kuster, of Berlin, proves conclusively that an amputation should be performed at once in diabetic gangrene of the leg, and should be done above the knee. If operation is performed below the knee, the flaps will become gangrenous. It has been noted that sugar will sometimes disappear from the urine after an amputation. Of 11 amputations by Kuster, 6 recovered and 5 died; and of these 5, 3 had albumin in the urine as well as sugar.[1]

Heidelhain warmly advocates early high amputation, with the making of short flaps. When the patient dies after operation, he usually does so in coma. In any case after operation, treat the diabetes by means of drugs and diet. If amputation is refused or if the gangrene is not upon an extremity, treat the gangrenous area by hot antiseptic fomentations, the daily removal of portions of dead tissue, the administration of antidiabetic drugs, and the use of suitable articles of diet. Never fail to examine the urine in every case of gangrene, for diabetes might be present when it had not been suspected. Surgical operations upon diabetics are, of course, very dangerous, and are only advised in emergencies, because the wound is apt to slough and coma may arise.

Gangrene from ergotism is a peripheral dry gangrene arising from tonic vascular contraction produced by the ergot in bread made from diseased rye. The gangrene is

[1] See the convincing article of Charles A. Powers, in *Amer. Journal of Med. Sciences*, Nov. 11, 1892.

preceded by anesthesia, muscular cramp, tingling pains, itching, and "gradual blood-stasis in certain vascular areas" (Osler). This form of gangrene occurs in epidemics where rye-bread is largely used, but is very rare in the United States. It usually affects the fingers or toes, but may involve an entire limb, and may be symmetrical. In acute cases death occurs in from seven to ten days.[1] In severe chronic cases await a line of demarcation and then amputate. In superficial cases dress with hot antiseptic fomentations and elevate the part, and every day take scissors and forceps and remove the loose crusts.

Gangrene from Frost-bite.—Frost-bite is most common in the fingers, toes, nose, and ears, but the genital organs, the cheeks, the chin, the feet and legs, and the hands and arms may be attacked. Cold causes a primary contraction of the vessels and pallor and numbness of the part. After reaction the vessels dilate, the part reddens and swells, and a burning sensation or actual pain is experienced. In a trivial frost-bite the swelling and redness usually disappear after a few days, but in some cases the redness is permanent, and in many cases the redness returns under the influence of slight cold (see Chilblains).

In a more severe frost-bite the affected part becomes purple and covered with vesicles, and gangrene may or may not follow. When parts have been badly frozen the peripheral portions dry up. The parts are deprived of all blood because of contraction of the vessels and because plasma coagulates at a few degrees above freezing. Cold disorganizes the blood, breaking up white corpuscles with the liberation of fibrin-ferment and the subsequent coagulation of plasma, and destroying red corpuscles with the liberation of hemoglobin. The thrombosis which is established prevents circulation, and the tissue-cells are damaged beyond repair. The parts are bloodless and anesthetic, and a line of demarcation forms. Hence we note that severe frost-bite causes dry gangrene. If a part which is not so badly frozen is brought suddenly into a warm atmosphere, hyperemia takes place when the blood runs into the frosted tissues, blebs form, and moist gangrene may result. Areas of superficial gangrene are not uncommon. A frost-bite in which the skin is livid and not as yet gangrenous should be treated by frictions with snow or rubbing with towels soaked in iced water. As the skin becomes warmer and congestion disappears the part should be wrapped in cotton-

[1] Pick, in Heath's *Surgical Dictionary*.

wool. A sufferer from frost-bite should not suddenly be brought into a warm room. When gangrene follows, if only small areas be involved, allow the dead part to come away spontaneously, applying in the meanwhile hot antiseptic fomentations. If separation be delayed by cartilage, ligament, or bone, cut through the retaining structure. If amputation becomes necessary, await a line of demarcation, as it is not possible to be certain how high tissue-damage extends, and to amputate through devitalized parts would mean renewed gangrene.

Noma, or cancrum oris, is a condition beginning as a sloughing ulcer on the gums or cheeks; it produces thrombosis and gangrene. It affects young children who live amid filth and squalor or who are convalescing from acute fevers. This disease may destroy large portions of the cheeks and jaws. The constitutional symptoms are diarrhea, fever, and great exhaustion. Death is the usual result, due frequently to septic bronchopneumonia (Bowlby). Lingard has found a bacillus which he believes is causative of noma, but most observers consider pus organisms as causative.

The *treatment* of noma consists in destruction of the diseased tissue by nitric acid or the actual cautery, the use, locally and often, of peroxid of hydrogen and antiseptic washes, and, internally, the employment of nutritious food, stimulants, and tonics. After arrest of the gangrene a plastic operation may be required.

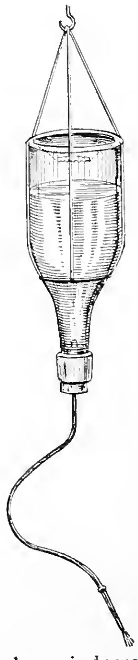


FIG. 49.—Improvised apparatus for the irrigation of a wound.

Sloughing is a process by which visible portions of dead tissue are separated. These visible portions are called "sloughs;" if they were large, they would be called "gangrenous masses." A large septic slough is a gangrenous mass; a small gangrenous mass is a slough; there is no difference in the process, which corresponds to the formation of a line of demarcation. Sloughing requires thorough and frequent irrigation with an antiseptic fluid, removal of the sloughs, and antiseptic treat-

ment. An irrigator can be improvised from an ordinary bottle (Fig. 49). Antiseptic fomentations are applied until granulation is well advanced. In some cases continuous irrigation with a hot antiseptic fluid is useful; in other cases continued immersion in a hot antiseptic solution is employed.

Phagedena is a process (most common in a venereal sore) in which the surrounding tissues are rapidly eaten up, the sore becoming jagged and irregular, with a sloughy base and thin edges; the discharge becoming thin and reddish, and the encircling tissues becoming deeply congested. This ulcer has no tendency to heal. It is due to a specific poison which has not yet been isolated. *Noma vulvæ* is a form of phagedena which attacks the genitals of little girls who are unhealthy, dirty, or convalescent from a specific fever.

The **treatment of phagedena** consists in repeated touching with tincture of chlorid of iron and the local use of iodoform, the employment of continued irrigation or immersion in hot antiseptic fluids, or the application of the cautery, chemical or actual. After using the cautery the part is dressed with hot antiseptic fomentations. Whatever else is done, tonics, stimulants, and nutritious diet must be given.

Decubitus, Decubital Gangrene, or Bed-sore.—A bed-sore is the result of local failure of nutrition in a person whose tissues are in a state of low vitality from age, disease, or from injury. The arterial condition of the aged favors the development of bed-sores. Such sores are due to pressure, aided it may be by some slight injury or by the irritation of urine, feces, sweat, crumbs or other foreign bodies in the bed or by wrinkling of the sheets. The pressure destroys vascular tone, stasis results, thrombosis occurs, and gangrene follows. In some cases, after pressure is removed there are stasis, vesication, suppuration, and the formation of an ugly ulcer, surrounded by a zone of swelling and hyperemia. These ordinary pressure-sores arise like splint-sores due to the pressure of a splint upon the tissues over a bony prominence. They occur over the heels, elbows, scapulæ, trochanters, sacrum, and nucha. The pressure interferes with the blood-supply, the weakened tissues inflame, vesication occurs, sloughs form, and an ugly ulcer is exposed. When a bed-sore is about to form the skin becomes red and edematous. Pressure with the finger drives the color out rather slowly. The color becomes purple or black, a slough forms and separates, and a large, irregular, foul cavity is exposed. The discharge is profuse and offensive. The

parts about are swollen and red. If the sore is not upon an anesthetic part, much suffering is produced by it. Bed-sores are most common in paralyzed parts; such parts are anesthetic, and injurious pressure is not painful and does not attract attention, and in such parts there is vaso-motor paresis.

The acute bed-sores of Charcot are seen during certain diseases and after some injuries of the nervous system. These sores are usual over the sacrum in acute myelitis, and may appear in four or five days after the beginning of a disease or the infliction of an injury. The surgeon sees acute bed-sores upon the buttock of the paralyzed side after brain-injuries, and over the sacrum in spinal injuries. Some believe these sores are due to vaso-motor disorder; but others, notably Charcot, attribute them to disturbance of the trophic nerves or centers.

Treatment of Bed-sores.—The "ounce of prevention" is here invaluable. From time to time, if possible, alter the position of the patient, keep him clean, maintain the blood-distribution to the skin by frequent rubbing with alcohol and a towel, keep the sheet clean and smooth, and in some situations use a ring-shaped air-cushion to keep pressure from the part. When congestion appears (paratrimma, or beginning sore), at once use an air-cushion or a water-bed and redouble the care to frequently change the position of the patient. Not only protect, but also harden, the skin. Wash the part twice daily and apply spirits of camphor or glycerol of tannin; or rub with salt and whiskey (ʒij to Oj); or apply a mixture of ʒss of powdered alum, f℥ij of tincture of camphor, and the whites of four eggs; or paint with corrosive sublimate and alcohol (gr. ij to ℥j); or apply tannate of lead or equal parts of oil of copaiba and castor oil; or paint on a protective coat of flexible collodion.

When the skin seems on the verge of breaking, paint it with a solution of nitrate of silver (gr. xx to ℥j). When the skin breaks, a good plan of treatment is to touch once a day with silver solution (gr. x to ℥j) and cover with zinc-ichthyol gelatin. We can wash the sores daily with 1 : 2000 corrosive-sublimate solution, dust with iodoform, and cover with soap plaster, with lint spread with zinc ointment, or with dry aseptic gauze. When sloughs form, cut most of them off with scissors after cleaning the parts, slit up sinuses, and use antiseptic fomentations. In sloughing Dupuytren employed pieces of lint wet with lime-juice and dusted the sore with cinchona and charcoal. In obstinate cases use the continu-

ous hot bath or the ice poultice. When the sloughs separate, dress antiseptically or with equal parts of resin cerate and balsam of Peru. If healing is slow, touch occasionally with silver solution (gr. x to ℥j). Bed-sores, being expressive of lowered vitality, demand that the patient shall be stimulated, shall be well nourished, and shall sleep soundly.

Ludwig's Angina (*Angina Ludovici*).—This disease is a streptococcus infection about the submaxillary gland and the cellular tissue beneath the mucous membrane of the floor of the mouth and of the upper portion of the neck. The inflammation eventuates in suppuration and gangrene. The disease arises as a painful swelling in the neighborhood of the submaxillary gland. The swelling rapidly increases, involves the neck and floor of the mouth, causes great difficulty in opening the mouth and in swallowing, and may lead to edema of the glottis.[1] The constitutional symptoms are those of septicemia or pyemia. The disease may arise in an apparently healthy man or during or after an infectious fever.

Treatment.—At once incise below the body of the lower jaw, open the submaxillary space, cut away gangrenous tissue, paint with pure carbolic acid, pack with iodoform gauze, and apply hot antiseptic fomentations. The constitutional treatment is that of septicemia.

Postfebrile Gangrene.—Dry or moist gangrene may follow any fever, but is most frequent after typhoid (may follow typhus, influenza, measles, scarlet fever, etc.). Keen tells us that the gangrene resulting from arterial obstruction is apt to be dry, and that from venous obstruction is usually moist. The same observer has collected 203 cases.[2] It is most usual in the lower extremities, but may appear in the upper extremities, cheeks, ears, nose, genitals, lungs, etc. Some writers have assigned as the cause weakness of cardiac action, but most observers believe an obstructing clot is the usual cause. This clot may come from the heart, but is usually secondary to endarteritis due to the action of the toxins of the bacilli of the specific fever. Keen shows that in some cases gangrene is due to obstruction of peripheral vessels and not of a main trunk. Gangrene most often appears late in the course of the fever, and may begin as early as the fourteenth day of the typhoid, but may arise far into convalescence. In rare cases gangrene arises after thrombophlebitis. In the course of a continued fever frequent

[1] Tillmann's *Text-book of Surgery*, translated by B. T. Tilton.

[2] Keen, on the *Surgical Complications and Sequels of Typhoid Fever*.

examinations should be made to see that gangrene is not arising. Keen says particular examination from time to time should be made of the lower extremities, and in young girls, of the genitals. If gangrene arises in an extremity, apply antiseptic dressings, wait for a line of demarcation, and then amputate. If gangrene occurs in other regions, remove the dead tissue and employ hot antiseptic fomentations.

Rules when to Amputate for Gangrene.—In *dry* gangrene, due to obstruction of a non-diseased artery, wait for a line of demarcation. In *senile* gangrene, if it affect only one or two toes, let the dead parts be cast off spontaneously. If a greater area is involved or the process spreads, amputate above the knee without waiting for the line. In *ordinary moist* gangrene wait for a line of demarcation. In *traumatic spreading* gangrene amputate at once. In *hospital* gangrene and in *Raynaud's* gangrene wait for a line of demarcation. In *diabetic* gangrene amputate at once, high up. In *ergot* gangrene, in *postfebrile* gangrene, and in *frost* gangrene wait for a line of demarcation.

IX. THROMBOSIS AND EMBOLISM.

Thrombosis is the antemortem coagulation of blood in the heart or in a vessel, the coagulum remaining at its point of origin and plugging up the vessel partially or completely. The process is known as thrombosis; the clot is called the thrombus. This process is an essential part in the arrest of hemorrhage; it occurs in phlebitis and arteritis, and affords a frequent basis for embolism. Thrombi may form in the veins, in the arteries, and in the heart. Clotting is due to destruction of white blood-cells, fibrin-ferment being set free, causing the union of calcium and fibrinogen and thus forming fibrin. Thrombosis is more common in the veins than in the arteries, the slow blood-current and the existence of valves favoring the deposit, though not causing it. A thrombus forms gradually, being deposited layer by layer, hence it is stratified or laminated. Fig. 50 shows a thrombus in a vein. All thrombi are either septic or aseptic, and they are also spoken of as fibrinous, red, hemostatic, leukocytic, etc.

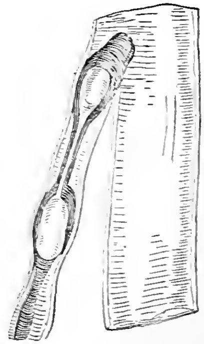


Fig. 50.—Thrombus in the saphenous vein (Green).

Causes of Thrombosis.—The essential cause of all intravascular thrombi is damage to the endothelial coat. Any condition which causes the blood to contain an excess of fibrin-forming elements favors thrombosis, in the sense that a slight injury of the vascular endothelium will be followed by clot formation. Among conditions favoring thrombosis we must note particularly slowing of circulation, however caused. Among special favoring conditions are retarded circulation in tuberculosis, influenza, and fevers, the blood clotting behind the vein-valves after the endothelium has been damaged by toxins; inflammations; the pressure of a bandage or of a splint; varicose veins; ligation of a vessel; injuries of a vessel; foreign bodies in a vessel; atheroma in arteries; sutures in a vessel; certain diseases, such as gout, typhoid fever, pregnancy, and septic processes; phlebitis or arteritis arising in the vessel or from extension of surrounding inflammation; and entrance of specific organisms.

It has been asserted that so long as the endothelium of a vessel is uninjured a clot does not form. Slowing of the blood-current in aseptic conditions, it is now taught, will not cause thrombosis. One of the functions of the endothelial coat is to keep the blood fluid by preventing corpuscular disintegration. A thrombus can form only when fibrin-ferment is set free, and fibrin-ferment can be set free only when white corpuscles disintegrate. When moving blood coagulates, the third corpuscles first settle out, and then the leukocytes. This is known as the white or "antemortem" thrombus—the clot of moving blood. Thrombi from moving blood are rarely purē white: they contain some red corpuscles, forming mixed thrombi. The red thrombus plugs vessels which are cut across or ligated; it also occurs in septic processes, and is formed after death. A thrombus soon undergoes a change. An aseptic clot is usually "organized," that is, absorbed and replaced by fibrous tissue. The walls of the injured vessel become filled with leukocytes, leukocytes invade the clot, the endothelium proliferates, and the young cells follow the colonies of leukocytes into the thrombus. The thrombus is gradually removed by leukocytes and replaced by fibroblasts, the new tissue is vascularized and becomes granulation-tissue, the granulation-tissue is converted into fibrous tissue, and the fibrous tissue contracts. In some rare instances a thrombus is implanted on the wall of the vessel, and the tube is not permanently occluded. In most instances the vessel is converted into a narrow cord of

fibrous tissue. A thrombus may degenerate and break down (fatty degeneration), giving rise to emboli or undergoing calcification. A calcified thrombus in a vein is known as a phlebolith. An infected thrombus may undergo liquefaction, infective emboli being set free (Fig. 51). A thrombus in an artery is apt to extend to the first collateral branch, but does not pass higher, the blood-current into the branch preventing further extension. Remember this fact when an artery is cut near a large branch. If we simply tie the artery, such a short clot will be formed that the vessel will not be obliterated. Tie not only the artery, but also the branch. A clot in a vein may extend a long distance. The author has seen in a post-mortem examination a venous thrombus reaching from the ankle to the vena cava. A spreading clot of this sort is known as a propagated thrombus.

FIG. 51.—Infected thrombus of a vein (schematic).

Symptoms.—The symptoms are dependent on the seat of the obstruction. An organ or a part of an organ may exhibit functional aberration. The local signs in a vessel accessible to touch or sight are the presence of a clot; if it be in an artery, anemia and the absence of pulse below the clot; if it be a vein, swelling and edema below it. There is usually pain at the seat of trouble, and anesthesia below it. Moist gangrene may follow venous thrombosis, and dry gangrene, arterial thrombosis. Thrombosis of the mesenteric vein is followed by gangrene of the bowel. Thrombophlebitis is a spreading inflammation of a vein in which a septic thrombus forms. We see this condition sometimes in the lateral sinus of the brain as a result of suppuration in the middle ear; in any of the cerebral sinuses after infected compound fracture of the skull; and in the uterine veins in puerperal sepsis. Infective thrombophlebitis is an early step in pyemia. Thrombo-arteritis is a spreading inflammation of an artery in which a septic thrombus forms or in which a septic embolus lodges. It occasionally attacks an aneurysmal sac.

Treatment.—If a thrombus forms in a large vessel of a limb, raise the limb a few inches from the bed, keep it perfectly quiet to avoid detachment of fragments (emboli), apply a bandage from the toes up, and place hot bottles around the extremity. The great danger is the formation of emboli, so

movements and rough handling are to be avoided. Gangrene is another danger, hence favor venous return and the development of the collateral circulation by warmth, elevation, and bandaging. In septic thrombophlebitis, if the vessel is accessible, tie it above and below the clot, open the vessel, remove the clot, irrigate, and pack the wound with iodoform gauze. Internally the treatment is stimulant and supporting. Massage is unsafe in any condition of thrombosis, and is particularly dangerous in septic thrombosis. In thrombo-arteritis treat as in thrombophlebitis. If gangrene follows thrombosis, treat as previously directed (p. 154).

Embolism signifies vascular plugging by a foreign body (usually a blood-clot) which has been brought from a distance. Emboli may arise either in the venous or in the arterial system, .but lodge only in an artery, in capillaries, or in the veins of the liver. The initial thrombus may form upon a diseased heart-valve or in a vein. It may be composed of fat, micro-organisms, air, or a portion of a tumor. An embolus is arrested when it reaches a vessel whose diameter is less than its own. It is usually caught just above a bifurcation. When an embolus lodges, it at once partially or entirely obstructs the circulation, and increases in size by thrombosis. A non-septic embolus usually " organizes," and, as described on page 168, is replaced by fibrous tissue. A soft embolus may disintegrate and permit of re-establishment of the circulation. An embolus may cause an aneurysm. A septic embolus breaks down, forms a metastatic abscess, and sends other emboli onward. Fig. 52 shows an impacted embolus.

An embolus is more serious than a thrombus : it causes sudden plugging, which makes dangerous anemia inevitable, and it will produce gangrene if the collateral circulation fails. Embolism of the mesenteric artery causes necrosis of the intestine. In organs with terminal arteries (spleen, kidney, brain, and lung) there is no collateral circulation and embolism causes infarction. The embolus produces an area of anemia ; the removal of all propulsion upon the venous blood causes it to flow back and stagnate, and vascular elements exude, forming a wedge-shaped area of red tissue, the embolus being the apex of the wedge. This is known as the " red infarction," and is often seen in the lung (Fig. 53). The white infarction, seen in the brain and kidney, is not due to retrogression of venous blood, but is due to anemia and resulting coagulation-necrosis. A septic embolus causes

septic thrombosis and a septic infarction, and a septic infarction is followed by suppuration and the production of a pyemic abscess. If emboli come from a thrombus in one of the veins of the pulmonary circulation, they lodge in the lungs, and rarely, though occasionally, pass through. Emboli formed in vessels of the systemic circulation lodge most often in the lungs, brain, kidney, or spleen (Nancrede). Emboli passing into the portal vein lodge in the liver.

Symptoms.—The symptoms depend upon the organ involved. They are sudden in onset, and consist of loss of

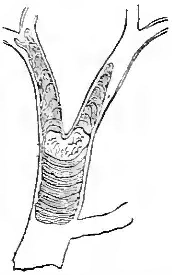


Fig. 52.—Embolus impacted at bifurcation of a branch of the pulmonary artery (Green).

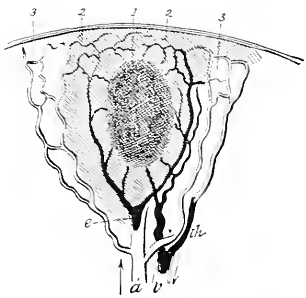


Fig. 53.—Diagram of a hemorrhagic infarct: *a*, artery obliterated by an embolus (*e*); *v*, vein filled with a secondary thrombus (*th*); 1, center of infarct, which is becoming disintegrated; 2, area of extravasation; 3, area of collateral hyperemia (O. Weber).

function which may be permanent or which may be followed by inflammation, softening or gangrene. Embolism of the cerebral arteries may cause aphasia, paralysis, or coma. Embolism of the pulmonary artery may cause almost instant death. Embolism of the central artery of the retina causes blindness. Embolism of a large artery of a limb produces symptoms identical with thrombus, except more sudden and decided. Embolism of the superior mesenteric artery produces symptoms similar to those caused by acute intestinal obstruction.

Treatment.—The treatment of aseptic embolism depends upon the part involved. In a limb, keep the part warm in order to stimulate the collateral circulation, elevate several inches from the bed, apply a bandage lightly from the periphery, and insist on perfect quiet. Massage is unsafe. If gangrene ensues, await a line of demarcation and amputate. In septic thrombo-arteritis in an accessible region it would be good surgery to act as in septic thrombophlebitis. After an

operation upon veins (as the operation for varicocele or for hemorrhoids), after a cutting operation, and after fracture, avoid as much as possible movements or handling, as fragments of thrombus may be detached. Operations upon the rectum may be followed by hepatic embolism and abscess of the liver.

Fat-embolism is an accumulation in the capillaries of liquid fat after injuries of adipose tissue, high tension forcing the fat into the open mouths of veins. Some little fat may get into the blood by means of the lymphatics. Fat-embolism occasionally arises during osteomyelitis, after extensive bruises, crushes, or lacerations, and after amputations, fractures, resections, or rupture of the liver.[1] This fluid fat accumulates especially in the capillaries of the lungs and brain.

Symptoms.—The symptoms are those of edema of the lungs and exhaustion, often with coma or delirium, and sometimes, in the beginning, are wrongly thought to be due to shock. There are restlessness, dyspnea, rapid pulse and respiration, normal or subnormal temperature, and cyanosis. If pulmonary edema becomes marked, the patient spits up a bloody froth. If life is prolonged a day or two, oil is found in the urine. Small amounts of oil may be found in the urine after serious injuries or operations when no symptoms of embolism exist. Nevertheless, the presence of the oil is always an ominous sign, and is often a warning. These symptoms never occur until at least twelve hours after the accident, and rarely before the third day. The symptoms occur at a later period than those of shock, and at an earlier period than those of ordinary embolism of the lung. If some of the oil is forced through the vessels of the lung, it will lodge in other regions and produce other symptoms. Oil may appear in the urine as above stated. Urinary suppression may occur. Delirium may arise or the patient may pass into coma. Severe cases of fat-embolism are commonly fatal; milder cases are often recovered from.

Treatment.—The treatment consists in the administration of stimulants, such as strychnin, alcohol, and carbonate of ammonium, the use of external heat; the use of oxygen by inhalation; and the administration of diuretics and of nitroglycerin hypodermatically. Artificial respiration may tide a patient over a crisis. If an external wound exists, the drainage must be free, and the damaged part should be thoroughly immobilized. In order to prevent fat-embolism after a severe injury insist on rest. Massage used early after some

[1] G. H. Makins, in Heath's *Dictionary*.

injuries is dangerous, as it may force fluid fat into the vessels. When a severe contusion causes the formation of a large cavity filled with blood Groubé advises incision, to lessen the danger of fat-embolism.[1]

Air-embolism.—Air may enter a vein during a surgical operation or it may be injected accidentally while giving a hypodermatic injection, hypodermoclysis, or a saline infusion into a vein. It is very rarely that any symptoms follow. It was long thought that such an accident must be extremely dangerous. Dr. Hare's experiments indicate that quantities of air may be injected into the veins of a dog without apparent harm. The entry of a small amount of air into the veins of a human being will not be apt to induce dangerous symptoms, but it may be fatal. The more rapidly it is introduced and the greater the amount, the greater is the danger. The manner in which it can induce death is doubtful. Some maintain that it causes the blood in the right side of the heart to froth, and thus prevents normal action of the valves, the heart becoming unable to propel blood through the lungs. If a surgeon divides a large vein, air may be sucked in, and there is particular danger of such an accident if a vein at the root of the neck or a cerebral sinus is torn or incised. If such an accident happens, there is a sucking sound and serious symptoms may or may not follow. If serious symptoms are produced, they arise suddenly, and consist of extreme failure of circulation, gasping for air, convulsions, and possibly death.

Treatment.—Compress the vein with the finger and clamp it quickly. Suspend the anesthetic, lower the head, employ artificial respiration and inhalation of oxygen, and give strychnin hypodermatically.

X. SEPTICEMIA AND PYEMIA.

Septicemia, or sepsis, is a febrile malady due to the introduction into the blood of pyogenic organisms or the products of pyogenic organisms or saprophytic bacteria. There is no one special causative organism, and any microbe which produces inflammatory and febrile products may cause it. Either streptococci or staphylococci may be present. Septicemia arises by absorption of septic matter by the lymphatics. Clinically we make two forms of septicemia: (1) sapremia, septic or putrid intoxication; and (2) septic infection, true or progressive septicemia. In these conditions the area of infection is usually discovered by the surgeon;

[1] *Rev. de Chir.*, July, 1895.

but when it cannot be located the disease is called by the Germans cryptogenetic septicemia.

Sapremia, septic or putrid intoxication, is due to the absorption of poisonous ptomaïns from a putrefying area. The bacteria do not enter the blood, but their toxins do, and, as these toxins are active poisons, the condition is comparable to poisoning by successive alkaloidal injections, the symptoms and prognosis depending upon the dose. Not unusually there is absorption not only of the toxins of saprophytic bacteria, but also the toxins of pyogenic micro-organisms. Even if some of the organisms enter the blood, they do not multiply in this fluid. Slight symptoms and recovery follow a small dose; grave symptoms and death follow a large one. The poison does not multiply in the blood, and a drop of the blood of a person laboring under putrid intoxication will not produce the disease when introduced into the blood of a well person; in other words, the disease is not infective. Considerable putrid material must be absorbed to cause sapremia. What is known as surgical fever is due to the absorption of a small amount of putrid or fermented wound-fluid, and is in reality a mild form of sapremia. If sapremia arises, it does so soon after the infliction of a wound, and after a large rather than small wound, when a large amount of wound-fluid is pent up under pressure. It may follow labor where putrid fluid is retained in the womb, may follow an injury of or an operation upon a joint, may follow amputation where decomposing blood-clot or wound-fluid is pent up within the flaps, or may ensue upon an abdominal operation or injury. In sapremia there always exist a considerable absorbing surface and a large amount of dead matter which has become putrid. Roswell Park points out[1] that sapremia arises from putrefaction of a blood-clot or wound-fluids which are retained like foreign bodies in the tissues, and does not arise from putrefaction of the tissues themselves. He speaks of the condition as due to the absorption of poison from a "putrid suppository." Sapremia will not occur after granulations form. The term putrefaction is used because this is the usual change, but any fermentative organism may cause the disorder. Sapremia is a malignant form of surgical fever, and its existence means an ill-drained wound, and a fermenting and probably putrid collection of blood-clot or wound-fluid.

In sapremia there is congestion of the stomach, intestines, and other abdominal viscera, particularly the kidneys, and also of the brain. Numbers of red blood-cells disintegrate.

[1] *Treatise on Surgery by American Authors.*

Symptoms.—The patient often seems to react incompletely from the injury, he feels miserable, complains of headache, nausea, and pain in the back and limbs, or, he may react and in a day or two develop this condition of malaise. In some cases an aseptic fever is directly succeeded by sapremia. In most cases of sapremia, between twenty-four hours and two or three days after labor, after an injury, or after an operation, there is a chill, or at least a chilly sensation, though in some cases this is wanting. The temperature rapidly rises to 103° F. or even more. There are severe headache, dry and coated tongue, rapid and weak pulse, nausea and often vomiting, diarrhea, great prostration, restlessness, muscular twitching, and active delirium. The wound is found to be foul, and often there is drying up of wound-discharge. There is diminution or suppression of urine, and a strong tendency to congestion of various organs. Jaundice is not unusual. Blood-examination shows leukocytosis and corpuscular disorganization. Petechial spots are often noticed upon the skin. They occur also upon mucous membranes and serous surfaces, and result from the plugging of small vessels with detritus of broken-down red corpuscles and consequent vascular rupture. Great elevation of temperature often precedes death. In some cases the dose of poison is so large that the patient passes into rapid collapse without preliminary fever. Some cases are recovered from if the initial dose is not overwhelming and if additional doses are not absorbed. Many cases die of exhaustion. Some become linked with fatal pyemia or septicemia. The blood should always be examined for organisms by making cover-glass preparations.

Treatment.—The treatment consists in at once draining and asepticizing the putrid area and administering very large doses of alcohol and large medicinal doses of strychnin and digitalis. The patient should be purged and diaphoresis favored. The hot bath is valuable to cause sweating. The action of the kidneys must be maintained if possible. Purgatives, diuretics, and diaphoretics aid in removing the toxin, and stimulants sustain the strength of the patient during the elimination of the poison. Allay vomiting by champagne, cracked ice, calomel, cocain, or carbolic acid with bismuth. Give food every three hours. Feed the patient on milk, milk and lime-water, liquid beef-peptonoids, and other concentrated foods. Use quinin in stimulant doses. Antipyretics are useless. Watch for any visceral congestion, and treat it at once. The use of saline fluid by hypodermoclysis or intravenous infusion dilutes the poison and stimulates the heart,

skin, and kidneys to activity. Antistreptococcic serum is useless in sapremia.

Septic infection, or true septicemia, is a true infective process. In sapremia the blood contains toxins of putrefactive organisms, but not the organisms themselves. In septic infection the blood contains both pyogenic toxins and multiplying pyogenic organisms. In sapremia the causative condition is putrid material lodged like a foreign body in the tissues. In septic infection the tissues themselves are suppurating, and both bacteria and toxins are being absorbed by the lymphatics. Of course, septic infection may be associated with septic intoxication or may follow it. In suppurative fever the tissues suppurate, but only the pyogenic toxins are absorbed, and not the pyogenic organisms. In septic infection both the pyogenic bacteria and toxins enter the blood, and the bacteria multiply in the blood and produce continually increasing amounts of poison. The symptoms of sapremia depend on the dose. In septic infection only a small number of organisms may get into the blood, but they multiply enormously. The pus microbes cause true septicemia, and reach the blood chiefly through the lymphatics, but to some degree by penetrating the walls of vessels. A drop of blood from a man with septic infection will reproduce the disease when injected into the blood of an animal; hence the disease is truly infective. The wound in such cases is often small, but may be large, and is commonly punctured or lacerated, and the disease begins later after the infliction of a wound than does sapremia. No wound may be discoverable, the infection having arisen from an unrecognized focus of suppuration, for instance, gonorrhea, middle-ear disease, caries of teeth, tonsillar suppuration, appendicitis, etc. Septicemia in which the initial atrium of infection is not discovered is called cryptogenetic septicemia.

The organisms which are found in the blood and organs are staphylococci or streptococci, usually both. The blood is found to have lost much of its coagulating power; it remains fluid for some time after death, and minute hemorrhages take place in the brain, mucous membranes, skin, serous membranes, muscles, and various viscera. There may be inflammation of synovial and serous membranes. There is congestion of the gastro-intestinal tube and of the abdominal viscera. The lymph-glands are larger than normal and the spleen is notably enlarged. The wound contains numbers of bacteria.

Symptoms.—The type of this condition is met with in

puerperal septicemia or in an infected wound. The post-operative rise may continue for an undue time and septicemia develop. Septicemia may arise during the existence or after the abatement of sapremia, or may arise when the aseptic fever has passed away and when there has been no putrid intoxication. It begins in from four to seven days after labor or an injury, usually with a chill, which is followed by fever, at first moderate, but soon becoming high. In some cases there is a chilly sensation, but no distinct chill. There is always great prostration even before the chill. The fever presents morning remissions and evening exacerbations, and may occasionally show an intermission. When the remission begins there is a copious sweat. As the case progresses the temperature may fluctuate, and it often rises very high before death. The pulse is small, weak, very frequent, and compressible. The tongue is dry and brown, with a red tip. Sordes gather on the teeth and gums. Vomiting is frequent, and, as a rule, there is diarrhea. Low delirium alternates with stupor, and coma is usual before death. The great prostration is a noticeable and characteristic feature of the sufferer from septicemia. There are subsultus tendinum and carphologia. Toward the end the face often becomes Hippocratic. Visceral congestions occur. The spleen is enlarged, ecchymoses and petechiæ are noted, urinary secretion becomes scanty or is suppressed, and the wound becomes dry and brown. Blood-examination detects disintegration of red globules and marked leukocytosis. Cover-glass preparations made from the blood may disclose pyogenic bacteria. When septicemia arises from an infected wound, red lines due to lymphangitis are usually seen about it, and there is enlargement of related lymphatic glands. In some cases, however, the wound and the parts about it look normal.

The *prognosis* is bad, and in some malignant cases death occurs within twenty-four hours, but mild cases often recover.

The *treatment* is the same as for septic intoxication. Antistreptococcic serum is employed by some surgeons, but the value of this method is as yet doubtful.

Pyemia.—Pyemia is a condition in which metastatic abscesses arise as a result of the existence of septic thrombophlebitis, the disease being characterized by fever of an intermittent type and by recurring chills. It is not actually due to free pus in the blood, but to the passage into the blood of clots filled with toxins or infected by streptococci and staphylococci. After a wound is inflicted blood clots in the divided veins. If the wound-fluid becomes putrid, the in-

travenous clots may become filled with ptomaïns. If suppuration occurs, the clots may become filled with the toxins of pyogenic organisms or be invaded by the organisms themselves. Thus it becomes evident that pyemia may develop with sapremia or with septicemia. It may also develop when neither has existed. A suppurating focus about a vein may cause thrombophlebitis and clot formation even when no wound exists. This is seen in thrombophlebitis of the lateral veins secondary to suppuration of the middle ear.

A vessel-thrombus runs up in the lumen of a vein, and the apex of the clot softens, a portion of it is broken off by the blood-stream and carried as an embolus into the circulation. Many of these poisonous emboli enter into the blood and lodge in some vessels which are too small to transmit them, and at their points of lodgement form embolic, secondary, or metastatic abscesses. If the embolus contains only toxins the danger is infinitely less than if it contains bacteria. The secondary abscess if caused by a clot containing only toxins may not lead to further dissemination of disease. If the embolus contains bacteria, thrombophlebitis occurs about it, and new infected emboli form and are sent throughout the system. Wounds of the superficial parts and bones produce pyemic infarctions and metastatic abscesses of the lungs. When these infarctions break into fragments particles may return to the heart and lodge, or may be sent out through the arterial system to form other foci in distant organs. Infected areas connected with the portal circulation (intestinal injuries or suppurating piles) may produce abscess of the liver. Wounds of bones which open the medullary cavity or diploic structure are particularly apt to be followed by pyemia, and the disease may follow labor, phlegmonous erysipelas, and other conditions. Malignant endocarditis is called "arterial pyemia," and is due to endocardial embolic infection. In this disorder infected emboli lodge in the kidneys, the spleen, the alimentary tract, the brain, or the skin (Osler). Idiopathic pyemia is a misnomer. Some primary focus of infection must exist, as was pointed out when discussing septicemia.

Symptoms.—The wound often becomes dry and brown, and sometimes also offensive. A severe and prolonged chill or a succession of chills ushers in the disease; high fever follows, and drenching sweats occur. The chills recur every other day, every day, or oftener. After the sweat the temperature falls and may become nearly normal. The temperature often oscillates violently. The general symptoms of vomiting, wasting, etc., resemble those of septicemia. In some cases the

mind remains clear, in many the delirium is purely nocturnal. The skin becomes jaundiced, and a profound adynamic state is rapidly established. The blood shows disintegration of red corpuscles and leukocytosis. The spleen is enlarged. The lodgement of emboli produces symptoms whose nature depends upon the organ involved. Lodgement in the lungs causes shortness of breath and cough, with slight physical signs. Lodgement in the pleura or pericardium gives pronounced physical evidence. Lodgement in the spleen produces severe pain and great enlargement. The parotid gland not unusually suppurates.

In a suspected case of pyemia always examine for a wound, and if this does not exist, remember that the infection may arise from gonorrhea, osteomyelitis, suppuration in the middle ear, appendicitis, dental caries, tonsillar suppuration, abscess of the prostate, etc. Chronic pyemia may last for months; acute pyemia may prove fatal in three days. The chief complications are joint-suppuration, bronchopneumonia, pleuritis, endocarditis, pericarditis, peritonitis, pyelitis, venous thrombosis, and abscesses.

Treatment is the same as for septicemia. Open, drain, and asepticize any wound and any accessible secondary abscess.

XI. ERYSIPELAS (ST. ANTHONY'S FIRE).

Erysipelas is an acute, contagious, spreading capillary lymphangitis due to the streptococci of erysipelas, which grow and multiply in the smaller lymph-channels of the skin and its subcutaneous cellular layers and also in the lymph-channels of serous and mucous membranes. The disease is characterized by a rapidly spreading dermatitis, by a remittent fever due to absorption of toxins, and by a tendency to recurrence. It is always preceded by a wound, a scratch, or an abrasion, which may have been trivial and may never have been noticed. The so-called idiopathic erysipelas is preceded by a breach of surface continuity so small as to escape notice. The initial point of infection may be in the mouth, the nostril, the pharynx, the auditory meatus, between the fingers or toes, at the margin of a nail, or in a cutaneous furrow. The involved area may or may not suppurate. Suppuration does not require a mixed infection, as the streptococcus is identical with the *streptococcus pyogenes*. Erysipelas is most common in the spring and fall, and is most usually met with among those who are crowded into dark,

dirty, and ill-ventilated quarters; it attacks by preference the debilitated and broken-down (as alcoholics and sufferers from Bright's disease). The disease may become endemic in special places or localties. The poison of erysipelas will produce puerperal fever in a lying-in woman. The streptococcus was first obtained in pure cultures by Fehleisen. This organism is widely diffused. The question of identity with the streptococcus pyogenes is discussed on p. 41.

Forms of Erysipelas.—*Ambulant*, *erratic*, *migratory*, or *wandering* erysipelas is a form which tends to spread widely over the body, leaving one part and going to another. *Bullous* erysipelas is attended by the formation of bullæ. In *diffused* erysipelas the borders of the inflammation gradually merge into healthy skin. *Erythematous* erysipelas involves the skin superficially. *Metastatic* erysipelas appears in various parts of the body. *Puerperal* erysipelas begins in the genitals of lying-in women, producing puerperal fever. *Erysipelas simplex* is the ordinary cutaneous form. *Erysipelas neonatorum* begins in the unhealed navel of a newborn child and spreads from this point. *Typhoid* erysipelas occurs with profound adynamia. *Universal* erysipelas involves the entire body. *Cellulitis* is erysipelas of the subcutaneous layers. *Phlegmonous* erysipelas involves the skin and the cellular tissues, and causes suppuration, and often gangrene. *Edematous* erysipelas is a variety of phlegmonous erysipelas with enormous subcutaneous edema. *Lymphatic* erysipelas is characterized by rose-red lines due to lymphangitis. *Venous* erysipelas is marked by the dark color of venous congestion. *Mucous* erysipelas involves a mucous membrane. Erysipelas may attack the fauces, producing a very grave condition.

Clinical Forms.—The clinical forms are cutaneous erysipelas, cellulocutaneous or phlegmonous, cellulitis, and mucous erysipelas.

Cutaneous erysipelas most frequently attacks the face. A fever suddenly appears, rises rapidly, reaches a considerable height, is remittent in type, and usually terminates in four or five days by crisis. At the time of febrile onset spots of redness appear on the skin. These spots run together, and a large extent of surface is found to be red and a little elevated. Any wound, ulcer, or abrasion which exists becomes dry and unhealthy, and its edges redden and swell. The erysipelatous area of redness and swelling extends, its margin is usually sharply defined from the healthy skin, and the color fades at the original focus as the disease advances at

the periphery of the red area. The color fades at once on pressure and returns at once when pressure is removed. There is slight burning pain, which is increased by pressure. In the hyperemic area vesicles or bullæ form, containing first serum and later it may be sero-pus, but there is rarely genuine suppuration in cutaneous erysipelas. Edema affects the subcutaneous tissues, producing great swelling in regions where there is much loose cellular tissue (as in the eyelids). The anatomically related lymphatic glands may become large and tender. In an ordinarily strong person the color is bright red or more rarely dark red. A dusky color precedes suppuration. A blue color precedes gangrene or indicates profound cardiac and pulmonary involvement. Erysipelas spreads now in one direction, now in another, influenced, according to Pfleger, by the furrows of the skin. When the disease ceases to spread the swelling and redness gradually abate, and after they disappear desquamation takes place, and the blebs become dry and crusted.

In strong subjects the symptoms of cutaneous erysipelas are usually slight. In the old and debilitated the symptoms are typhoidal, delirium comes on, and death is usual. Possible complications are meningitis, pneumonia, septicemia, pleuritis, pyemia, endocarditis, arthritis, and albuminuria. Erysipelas neonatorum is generally fatal. In some instances an attack of erysipelas will cure an old skin eruption, a new growth, an ulcer, or an area of lupus. This is the erysipele salutaire of our French *confrères*.

Treatment.—Isolate the patient, asepticize a wound, if there be a wound, and administer a purge. Cases of cutaneous erysipelas occurring in a fairly healthy, young, or middle-aged subject, tend to get well without treatment. If a person is debilitated free stimulation is necessary. Tincture of chlorid of iron and quinin are usually administered. Nutritious food is important. For sleeplessness or delirium use chloral or the bromids; for high temperature, cold sponging. To prevent spreading some have advised injection of the healthy skin near the blush with a 2 per cent. carbolic solution or with fluid containing gr. $\frac{1}{16}$ of corrosive sublimate. A band of iodin painted on the skin may arrest the progress of the disease, and so may a ring streaked around a limb or about an erysipelatous area by lunar caustic. Kraske has suggested a method of preventing the spread of cutaneous erysipelas which is often effective. The patient is anesthetized. At about two inches from the margin of the redness a series of cuts are made into the skin, to a sufficient depth to

cause free oozing. Each cut is crossed by another cut and a ring of scarifications is made to surround the erysipelas. After the oozing ceases the scarified area is soaked for one hour with a solution of carbolic acid (1 : 20) or corrosive sublimate (1 : 2000). The part is dressed with pads wet with carbolic acid (1 : 40) or corrosive sublimate (1 : 2000). This operation causes the formation of a protective barrier of leukocytes. Locally, paint the inflamed area with equal parts of iodin and alcohol and apply lead-water and laudanum. The iodin is germicidal and quickly enters the lymph-spaces. The lead-water and laudanum allays the burning pain. If an extremity be involved, bandage it. Another good application is a 50 per cent. ichthyol ointment with lanolin. A very useful method is Von Nussbaum's. The author applies it somewhat modified, as follows: wash the part with ethereal soap, irrigate with a solution of corrosive sublimate (1 : 1000), dry with a sterile towel, apply an ointment of ichthyol and lanolin (50 per cent.), and dress with antiseptic gauze. Some use iced-water cloths and some prefer hot fomentations. Others apply borated talc or salicylated starch. Ringer advised painting every three hours with a mixture composed of gr. xxx of tannic acid, gr. xxx of camphor, and ℨiv of ether. J. M. Da Costa recommends pilocarpin internally in the beginning of a case. Antistreptococcic serum has been used in erysipelas, and great results have been claimed for it. Roger and Charrin's serum may be used. The dose is 30 c.c. It is asserted that under its influence the temperature soon becomes normal. We have had no personal experience with the serum treatment.

Cellulocutaneous or phlegmonous erysipelas is characterized by high temperature (104°–106° F.), the rapid onset of grave prostration, irregular chills, sweats, and a strong tendency to delirium. The constitutional condition may be one of suppurative fever, sapremia, septicemia, or pyemia. The parts are red, as in cutaneous erysipelas, and the tumefaction is vastly greater. The swelling is brawny, comes on early, increases with exceeding rapidity, induces a high degree of tension, and frequently produces sloughing or even cutaneous gangrene. The lymphatic glands are swollen, but the inflamed lymphatic vessels are hidden by the tumefaction. In most cases suppuration occurs, and when this happens the parts become boggy and the pus is widely disseminated in the subcutaneous and intramuscular tissues, and even into muscular sheaths and tendon-sheaths (purulent infiltration). When the disease abates sloughs form, which leave ulcers

upon being cast off. In bad cases muscles, vessels, tendons, and fascia may slough away. The commonest complications are suppression of urine, bronchopneumonia, congestion and edema of the lungs, meningitis, congestion of the kidneys, and acute pleurisy. Septicemia or pyemia may occur. We sometimes meet with this form of erysipelas after extravasation of urine. It is not a pure streptococcus infection. There is a mixed infection with other pyogenic cocci, and often with organisms of putrefaction.

Treatment.—At once asepticize and drain any existing wound, and dress such a wound with hot antiseptic fomentations. If there are inflamed lymph-vessels or glands above the area of cellulocutaneous infection, paint the skin above them with iodin and smear it with blue ointment. Make numerous incisions into the inflamed tissues. These incisions should be near together, and each cut should be two or three inches long. Spray the wounds by means of hydrogen peroxid in an atomizer, wash with corrosive-sublimate solution (1 : 1000), and pack each wound with iodoform gauze. Dress with many layers of gauze wet with a hot solution of corrosive sublimate and covered with a rubber-dam, a hot-water bag being laid upon the dressing. If sloughs form, cut them partly away and employ hot antiseptic fomentations. Change the dressings often. In some cases it may be necessary to employ continuous irrigation with warm antiseptic fluid, or continuous immersion in a hot aseptic or antiseptic bath. It is not unusually necessary to operate for the removal of enlarged lymphatic glands. In rare cases amputation is demanded. When granulations begin to form, treat as a healing wound. The constitutional treatment is that previously set forth as applicable to septicemia, viz., purgation, the use of diuretics and diaphoretics, the administration of strychnin, quinin, digitalis, alcoholic stimulants, and nourishing food. Antistreptococcic serum is employed by some. In severe cases employ hypodermoclysis or saline infusion into a vein.

Cellulitis.—Cellulitis is a microbic inflammation of the cellular tissue. It may be due to staphylococci, to streptococci, to other pyogenic bacteria, or to mixed infection with two varieties of pyogenic organisms. The commonest form is streptococcus infection, and this is a variety of erysipelas. Infection with the bacillus aërogenes capsulatus causes gangrenous cellulitis. In cellulitis of the subcutaneous tissue the organism finds entrance by means of a wound. Swelling precedes redness. The swelling is not so marked as in phlegmonous erysipelas, and the redness is darker and is

not so noticeable as in cutaneous erysipelas. The redness of cellulitis is about the wound, it spreads but does not fade at the center as does ordinary erysipelas, red lines due to lymphangitis ascend the limb from the infected wound, and the anatomically associated lymphatic glands enlarge. In the wound and its neighborhood there is severe throbbing pain. The constitutional symptoms of infection develop rapidly. In trivial cases the lymphatics dispose of the poison and suppuration does not occur. In severe cases pus forms about the wound and lymphatic glands may suppurate. Phlegmonous erysipelas may develop, septicemia or pyemia may arise.

Treatment.—Open, disinfect, and drain the wound. Paint iodin upon the skin over inflamed lymphatic vessels and glands and cover with ichthyol ointment. Dress the wound and the adjacent inflamed area with hot antiseptic fomentations. It may be necessary to make incisions as in phlegmonous erysipelas. In some cases it is necessary to remove breaking-down glands. The constitutional treatment is that used for septicemia.

XII. TETANUS, OR LOCKJAW.

Tetanus is a microbic disease invariably preceded by some injury and characterized by spasm of the voluntary muscles. The wound may have been severe, it may have been so slight as to have attracted no attention, or it may have been inflicted upon the alimentary canal by a fish-bone or other foreign body, or may have been situated in the nose, urethra, vagina, or ear. The so-called idiopathic tetanus is either not tetanus at all, or the term expresses the fact that we have not found the traces of an injury which did exist. Tetanus arises most frequently after punctured or lacerated wounds of the hands or feet, and before it appears a wound is apt to suppurate or slough; but in some instances the wound is found soundly healed. The fact that the bacillus of tetanus is anäerobic explains the comparative frequency with which punctured and lacerated wounds are attacked, for in such wounds the bacilli are deeply lodged in recesses or cavities into which air does not penetrate or are covered with discharges which exclude air. Nancrede points out that suppuration favors the growth of tetanus bacilli, because the pyogenic organisms consume oxygen. Tetanus may appear twenty-four hours after an accident, but it may not arise until several weeks have elapsed. It prevails more in certain

localities than in others. Colored people are very susceptible, and the disease may exist endemically. Tetanus is due to the growth in a wound of a bacillus (first described by Nicolaier and first cultivated by Kitasato), the toxic products of which, absorbed from the wound, poison the nervous system precisely as would dosing with strychnin. The bacilli are not taken into the blood, and only the toxic products are absorbed, hence tetanus is an intoxication. Tetanus bacilli or their spores are found particularly in garden-soil, in the dust of walls, walks, and cellars, in street-dirt, and in the refuse of stables.

Symptoms.—**Acute tetanus** begins within ten days of an accident. The usual period of incubation is from three to five days. In most cases the first symptom is stiffness of the jaw in opening the mouth. In some cases the first symptom is stiffness of the neck, and the patient believes he has "caught cold." In any case the neck soon becomes stiff, and finally both the neck and jaw are as rigid almost as iron. The muscles of deglutition become rigid on attempts at swallowing. The muscles of the back, legs, and abdomen are thrown into tonic spasm, but the arms rarely suffer. If the infected injury is on the hand or foot, that extremity usually is found to be rigid. Spasm of the face-muscles causes the *risus sardonicus*, or sardonic smile (contraction particularly of the *musculus sardonicus* of Santorini). The contraction of the muscles of the back is often so powerful as to bend the patient back like a bow and allow him to rest only on his occiput and heels. This condition is known as "opisthotonos." If he is bent forward, so that the face is drawn to the legs, it is called "emprosthotonos." If his body is curved sideways, it is designated "pleurosthotonos." An upright position is "orthotonos." The spasm may be so violent as to cause muscular rupture. The fixation of the jaw is called trismus.

The characteristic condition in tetanus is one of widely diffused tonic spasm, aggravated frequently by clonic spasms arising from peripheral irritations. These irritations may be draughts, sounds, lights, shaking of the bed, attempts at swallowing, contact of the bed-clothing, the presence of urine in the bladder or of feces in the rectum, or various visceral actions. The clonic spasms begin early in the case and become more frequent and more violent as the disease progresses. The muscles become more rigid and the attitude produced by the tonic contraction of the muscles is temporarily exaggerated. The forcible contraction of

the jaw may loosen or break teeth. The spasm of the diaphragm, of the glottis, and of the muscles of respiration may produce death and always produce great dyspnea. The man laboring under a tetanic convulsion presents a dreadful picture; he is bent into some unnatural attitude, the face is cyanotic and covered with drops of sweat, the lips are covered with froth which is often bloody, the eyes bulge and are suffused, and the countenance expresses deadly terror and suffering. The agonizing "girdle-pain" so often met with is due to spasm of the diaphragm. Each clonic spasm causes a hideous scream by the constriction of the chest forcing air through a contracted glottis. During the progress of the disease constipation is persistent, and retention of urine is the rule (because of sphincter spasm). The mind is entirely clear until near the end—one of the worst elements of the disease. Swallowing in many cases is impossible. Talking is very difficult and it is impossible to project the tongue. The muscles throughout the body feel very sore. The temperature may be normal, but it is usually a little elevated, and always rises just before death. Hyperpyrexia sometimes occurs (108°–110° F.), and the temperature may even ascend for a time after death. Insomnia is obstinate. In 80–90 per cent. of cases of acute tetanus death occurs in the course of two or three days. If a patient lives a week, his chance of recovery is good. Death may be due to exhaustion or to carbonic-acid narcosis from spasm of the glottis or fixation of the respiratory muscles.

Chronic tetanus comes on late after a wound (from ten days to several weeks). The symptoms are not so severe as in acute tetanus. The muscular spasm is widespread, but it may not be persistent, intervals of relaxation permitting sleep and the taking of food. Chronic tetanus may last some weeks, and in about 40 per cent. of cases the disease can be cured. *Trismus neonatorum* or *trismus nascentium*, the lockjaw of the newborn, is due to infection of the stump of the umbilical cord, and is practically invariably fatal. Hydrophobic tetanus, head tetanus, or cephalic tetanus, is a condition in which the spasms are confined chiefly to the face, pharynx, and neck, although the abdominal muscles are usually also rigid. It follows head-injuries, and gives a better prognosis than does general tetanus.

Diagnosis.—Tetanus may be confounded with strychnin-poisoning, with hysteria, or with tetany. Wood's table makes the diagnosis clear between tetanus and hysteria:[1]

[1] *Nervous Diseases*, by Prof. H. C. Wood.

TETANUS.	HYSTERICAL TETANUS.	STRYCHNIN-POISONING.
	Commences with blindness and weakness.	Begins with exhilaration and restlessness, the special senses being usually much sharpened. Dimness of vision may in some cases be manifested later, after the development of other symptoms, but even then it is rare.
Muscular symptoms usually commence with pain and stiffness in the back of the neck, sometimes with slight muscular twitching; come on gradually. Jaw one of the earliest parts affected; rigidly and persistently set.	Muscular symptoms commence with rigidity of the neck, which creeps over the body, affecting the extremities last. Jaws rigidly set before a convulsion, and remain so between the paroxysms.	Muscular symptoms develop very rapidly, commencing in the extremities, or the convulsion when the dose is large seizes the whole body simultaneously. Jaw the last part of the body to be affected; its muscles relax first, and even when, during a severe convulsion, it is set, it drops as soon as the latter ceases.
Persistent muscular rigidity very generally, with a greater or less degree of permanent opisthotonos, emprosthotonos, pleurosthotonos, or orthotonos.	Persistent opisthotonos and intense rigidity between the convulsions and after the convulsions have ceased, the opisthotonos and intense rigidity lasting for hours.	Muscular relaxation (rarely a slight rigidity) between the convulsions, the patient being exhausted and sweating. If recovery occurs, the convulsions gradually cease, leaving merely muscular soreness, and sometimes stiffness like that felt after violent exercise.
Consciousness preserved until near death, as in strychnin-poisoning.	Consciousness lost as the second convulsion comes on, and lost with every other convulsion, the disturbunce of consciousness and motility being simultaneous.	Consciousness always preserved during convulsions, except when the latter become so intense that death is imminent from suffocation, in which case sometimes the patient becomes insensible from asphyxia, which comes on during the latter part of a convulsion and is almost a certain precursor of death.
Draughts, loud noises, etc., produce convulsions, as in strychnin-poisoning: may complain bitterly of pain.	Crying-spells alternating with convulsions.	The "slightest breath of air" produces convulsion. Patient may scream with pain or may express great apprehension, but "crying-spells" would appear to be impossible.
Eyes open and rigidly fixed during the convulsion.	Eyes closed.	Eyes stretched wide open.
	Partial spasm in the leg, producing in Wood's cases crossing of the feet and inversion of the toes. If all the muscles were involved, eversion would occur, as the muscles of eversion are the stronger.	Legs stiffly extended with feet everted, as the spasms affect all the muscles of the leg.

Tetany is distinguished from tetanus by the milder nature of the spasms, by the greater limitation of the rigidity, by the fact that spasms begin in the hands or feet, not in the jaw and neck, and in most cases by periods of distinct intermittence.

Treatment.—Far better even than to treat tetanus well is to prevent it. Careful antisepsis will banish it as a sequence of surgical operations as thoroughly as it has banished septicemia. Every wound must be disinfected with the most scrupulous care. Every punctured wound is to be incised to its depth and thoroughly cleaned and drained. Puerperal tetanus is prevented by antiseptic midwifery, and tetanus neonatorum is obviated by the antiseptic treatment of the stump of the cord. When tetanus exists, always look for a wound, and if one is found, open it; if there are sloughs, cut them away, wash the wound with peroxid of hydrogen and then with a hot solution of corrosive sublimate (1 : 500), dry the wound with gauze, paint the surfaces of the wound with bromin, and secure drainage by packing with iodoform gauze. Dennis disinfects the wound with a solution of trichlorid of iodin ($\frac{1}{2}$ per cent.).

Keep the patient in a darkened, well-ventilated, and quiet apartment, so as to exclude as far as possible peripheral irritation. Watch for the occurrence of retention of urine, and use the catheter if it is necessary. Secure movements of the bowels by administering salines, castor oil, croton oil, or enemas. Give plenty of concentrated liquid food, and stimulate freely with alcohol. If swallowing causes convulsions, give an inhalation of nitrite of amyl before an attempt is made to swallow. If this treatment does not make swallowing possible, partially anesthetize the patient and feed him by means of a pharyngeal tube passed through the nose. Large doses of the bromid of potassium, or of this drug with chloral, give the best results, as far as drug treatment is capable of giving results. If bromid is used, give about ʒj every four to six hours. Other drugs that have been used with some success are gelsemium, morphin, curare, injections and fomentations of tobacco, physostigmin, anesthetics, cocain, and cannabis indica. An ice-bag to the spine somewhat relieves the girdle-pain. Hot baths have been advised.

Yandell says, in summing up Cowling's report on tetanus:[1] "Recoveries from traumatic tetanus have been usually in cases in which the disease occurs subsequent to nine days after the injury. When the symptoms last fourteen days, recovery is the rule, apparently independent of treatment.

[1] *American Practitioner*, Sept., 1870.

The true test of a remedy is its influence on the history of the disease. Does it cure cases in which the disease has set in previous to the ninth day? Does it fail in cases whose duration exceeds fourteen days? No agent tried by these tests has yet established its claims as a true remedy for tetanus."[1]

It is now claimed by some observers that we have a remedy which fulfils the requirements of Yandell in the tetanus antitoxin serum of Tizzoni. A horse is injected repeatedly with the toxins obtained from cultures of tetanus bacilli, the strength of the injections being gradually increased. Eventually the animal becomes immune to tetanus. Some days after the final injection a cannula is placed in the jugular vein of the immunized animal, blood is drawn into a sterile vessel and is permitted to coagulate during twenty-four hours, and at the end of this period the serum is separated from the clot, is evaporated to dryness in a vacuum over sulphuric acid, and the powder is placed in hermetically sealed glass tubes. In order to use the serum dissolve the powder in sterile water, in the proportion of 1 gm. to 10 c.c. The fluid serum sold in the shops bears this proportion to the powder. The serum can be given subcutaneously or intravenously or can be injected into the brain. If used subcutaneously, from 20 to 30 c.c. of the fluid serum should be injected into the abdominal wall, and this dose should be given every six or eight hours until there is improvement. Then from 5 to 10 c.c. should be given every six or eight hours. As the symptoms abate the dose is lessened and the intervals between the doses are increased. In a violent case of tetanus the first dose should consist of 40–50 c.c., and this can be repeated in four or five hours. In a case of tetanus which recovered, reported by Mixter, enormous doses were given. This patient received in the aggregate 3400 c.c. of serum, or 285 c.c. a day.[2] Roux and Borrel maintain that the toxins of tetanus pass from the blood into nervous tissue and are fixed in the nerve-cells. As the antitoxin when given hypodermatically or intravenously remains in the blood, it can only antidote the poison in the blood and not that in the nerve-cells. These observers advise that the antitoxin be placed where the toxins are active, that is, that it be thrown into the cerebrum. The skull is trephined or opened with a small drill, a blunt needle is passed to the depth of one and a half inches into the frontal lobe, and the serum is slowly injected.

[1] Quoted by Hammond, in his *Diseases of the Nervous System.*

[2] *Boston Med. and Surg. Jour.*, Oct. 6, 1898.

The serum should be concentrated. One gram of dry antitoxin is dissolved in 5 c.c. of water, and this amount is the proper dose. The opposite frontal lobe should also be injected either at once or the next day. Even when serum has been injected into the cerebrum it should also be given subcutaneously.

The value of the tetanus antitoxin is doubtful. It seems to distinctly benefit chronic tetanus, but to have only a trivial effect on the acute disease. Nancrede estimates that antitoxin treatment has lessened the mortality of acute tetanus about 5 per cent. The intracerebral injection is still an experiment. Kitasato has shown that injections of iodoform render animals immune, and Sonnani has maintained that this drug in a wound prevents the disease. If antitoxin is not obtainable, give hypodermatic injections of iodoform, 3 to 5 grs. *t. i. d.*

XIII. TUBERCULOSIS.

Tuberculosis is an infective disease due to the deposition and multiplication of tubercle bacilli in the tissues of the body. It is characterized either by the formation of tubercles or by a widespread infiltration, both of these conditions tending to caseation, sclerosis, or ulceration.

A tubercle is an infective granuloma, appearing to the unaided vision as a semitransparent gray mass the size of a mustard-seed. The microscope shows that a gray tubercle consists of a number of cell-clusters, each cluster constituting a primitive tubercle. A typical primitive tubercle shows a center consisting of one or of several polynucleated giant-cells surrounded by a zone of epithelioid cells which are surrounded by an area of leukocytes. When the bacillus obtains a lodgement the fixed connective-tissue cells multiply by karyokinesis, forming a mass of nucleated polygonal or round cells, called "epithelioid" from their resemblance to epithelial cells, and at the same time the blood-supply of the growth is limited by occlusion of surrounding vessels through multiplication of the cells of their endothelial coats. Some of the epithelioid cells

FIG. 54.—Synovial membrane, showing giant-cells (Bowlby).

proliferate, and others attempt to, but fail for want of blood-supply. Those which fail to multiply succeed only in dividing their nuclei and enormously increasing their bulk (giant-cells). Giant-cells, which may also form by a coalescence of epithelioid cells, are not always present. The presence of irritant bacterial products induces surrounding inflammation and numbers of leukocytes gather about the epithelioid cells (Fig. 54).

The bacilli, when found, exist in and about the epithelioid cells, and sometimes in the giant-cells. They may not be found, having once existed, but having been subsequently destroyed. Bacilli, when present, can easily be overlooked. In an active tubercular lesion, even if the bacilli be not found, injection of the tubercular matter into a guinea-pig will produce lesions in which they can be demonstrated. A tubercle may caseate—a process that is destructive and dangerous to the organism. Caseation is due to a coagulation-necrosis arising from direct microbic action upon a cellular area which contains no blood-vessels, the nutrition of the area being cut off by obliteration of surrounding vessels. This process starts at the center, and the entire tubercle becomes converted into a soft yellowish-gray mass. Caseation forms cheesy masses, which may soften into tubercular pus, may calcify, may become encapsuled by fibrous tissue, and may be replaced by an area of sclerosis.

A tubercle may undergo sclerosis, which is an attempt on the part of Nature to heal and repair. Coagulation-necrosis occurs in the center of the tubercle; "hyaline transformation proceeds, together with a great increase in the fibroid elements, so that the tubercle is converted into a firm, hard structure" (Osler). Infiltrated tubercle is due to the running together of many minute infective foci, or to widespread infiltration without any formation of foci. Infiltrated tubercle tends strongly to caseate.

The bacillus of tubercle, discovered by Koch, is a little rod with a length equal to about half the diameter of a red blood-corpuscle. It can be stained with anilin, and this stain is not removable by acids (it being the only bacillus except leprosy which acts in this way). In its growth the tubercle bacillus causes the formation of toxins, and the absorption of toxins induces constitutional symptoms. These bacilli exist in all active lesions: the more active the process the greater is their number. They may be widely distributed, and are occasionally though rarely identified in the blood. They exist in enormous numbers in phthisical sputum, but

are not found in the breath of consumptives. Their great medium of distribution is dried sputum mixed with dust. They are found in the milk of tubercular cows, and sometimes in the meat of diseased animals.

Infection may be due to hereditary transmission. Congenital tuberculosis is occasionally, though rarely, seen. Tuberculosis is apt to appear in young children. Some think this is due to infection from without upon tissues whose resistance is lowered by hereditary predisposition; others think it is due to a tardy development of the germs transmitted by heredity. That the disease may be present in a latent form is shown by the experiment in which the viscera of the fetus of a consumptive mother showed no tubercles, but produced the disease in guinea-pigs when inoculated.[1] Tuberculosis may arise by inoculation, inoculation-tuberculosis being seen in leather-workers and in those who dissect tubercular bodies (butchers and doctors are liable to anatomical tubercle). Osler mentions as other causes of inoculation the bite of a tubercular patient, the washing of infected garments, and circumcision in which suction is employed by an individual with phthisis. Granulation-tissue, chronic abscess, and areas of dermatitis may be infected from without (G. R. Fowler). Infection through the air is very common. The bacteria of the dried sputum adhere to particles of dust and are carried into the lungs. Infection by meat, milk, and other foods may arise by this dust settling upon them in quantity, but more often it is due to disease of the animals. Milk is a common vehicle of contagion, and it can be infected even when an ulcerated udder does not exist.

Infection is favored by hereditary predisposition—that is to say, by hereditary tissue-weakness, which, by maintaining a lowered momentum of nutritive processes, lessens the normal resistance to infection. Hutley studied 432 cases of tuberculosis. In 23.8 per cent. one or both parents had the disease (the father alone in 11.5 per cent., the mother alone in 9.9 per cent., and both in 2.4 per cent.). Two types of these predisposed persons are mentioned: (1) the sanguine type, or those with oval faces, clear skin, large blue eyes, long lashes, a nervous manner, precocious minds, little fat, and with long, slender bones, these children being often graceful and beautiful; and (2) those with stolid countenances, thick lips and noses, thick, muddy skin, dark, coarse hair, swollen necks, heavy bones, clumsy gait, and ungainly

[1] Quoted by Osler from Birch-Hirschfeld.

figure. The latter type is the phlegmatic form—the classical scrofula.

Tubercle tends to arise at points where the normal resistance of the tissue is lessened by disease or injury, the process of phagocytosis being in such a spot limited in activity, and the germicidal power of the body-fluids being at a low ebb. The organisms, which are destroyed by healthy cell-activities, are victorious when those activities are diminished. Catarrhal inflammations of the air-passages favor phthisis, and slight traumatism is not unusually followed by a development of tubercle. Severe traumatism is rarely followed by tubercular trouble. It is probable that in a slight traumatism a sufficient number of leukocytes do not gather, and a sufficient amount of serum is not effused to kill the bacteria. Lowered health, impure air, and improper or insufficient food all favor the development of tubercle. When an area becomes tubercular it is not unusual for indican to appear in the urine. Any tubercular process tends to spread locally and to produce inflammation. A tubercular area is always a danger to the system; from this as a focus dissemination may occur, tubercular lesions appearing in a distant part or general tuberculosis setting in.

Scrofula is not a disease. It is a condition of tissues in which low resisting power makes them hospitable hosts to invading bacilli of tubercle. Some observers teach that scrofula is tuberculosis of bones, glands, and joints; others teach that it is latent tuberculosis until some cause lights it into activity; while still others say that it is a tendency rather than a disease. It is certain that some lesions of scrofula are not tubercular (eczema capitis, facial eczema, corneal ulcers, granular lids, and chronic catarrhal inflammations), and that they result from ill-health, poor nutrition, bad air, and improper diet. A person who is recognized as of a scrofulous type may never develop tubercular lesions. It is unquestionable, however, that strumous subjects are peculiarly apt to develop true tubercular lesions. These lesions often appear after a tissue or an organ has become the seat of a primary non-tubercular inflammation; the bacilli, which could not live in the healthy tissue, thrive in the tissue weakened by disease. Scrofula is generally of congenital origin, one or both parents being tubercular, scrofulous, or in ill-health; it may, however, be acquired as a result of poor food, bad air, crowding, and general lack of sanitation. The scrofulous are very prone to develop tubercular lesions of bones, joints, and lymphatic glands.

Tubercular Abscess.—For description of Tubercular Abscess, see p. 134.

Tuberculosis of the Skin.—*Lupus* begins before the age of twenty-five, most usually upon the face, especially the nose. Three forms are recognized: (1) *lupus vulgaris*, in which pink nodules appear that after a time ulcerate and then cicatrize partly or completely. These nodules resemble jelly in appearance; (2) *lupus exedens*, in which ulceration is very great; and (3) *lupus hypertrophicus*, in which large nodules or tubercles arise. Lupus may appear as a pimple, as a group of pimples, or as nodules of a larger size. The ulcer arises from desquamation, and is surrounded by inflammatory products which, by progressively breaking down, add to the size of the raw surface. The ulcer is usually superficial, is irregular in outline, the edges are soft and neither sharp nor undermined, the sore gives origin to a small amount of thin discharge, the parts about are of a yellow-red color, the edges are solid and puckered and scar-like, and there is no pain. The ulcer is often crusted, the crusts being thin and of a brown or black color; it may be progressing at one point and healing at another; it is slow in advancing, but often proves hideously destructive. The scars left by its healing are firm and corrugated, but are apt to break down. Clinically it is separated from a rodent ulcer by several points. The rodent ulcer is deep, its edges are everted, and the parts about filled with visible vessels. It is not crusted, has not a puckered edge, does not spontaneously heal at any point, and its edges and base are hard.

Anatomical tubercle, the *verruca necrogenica* of Wilks, is due to local inoculation with tubercular matter. It is met with in surgeons, the makers of post-mortems, leather-workers, and butchers, usually upon the backs of the hands and fingers. It consists of a red mass of granulation-tissue having the appearance of a group of inflamed warts. Pustules often form.

Scrofulodermata or **tubercular gummata** are chronic inflammations of the skin, the granulation-tissue product of which caseates, mixed infection occurs, and small abscesses, sinuses, or ulcers form. A tubercular ulcer has a floor of a pale color, and has no granulations at all, or is covered with large, pale, edematous granulations. The discharge is thin and scanty. It is surrounded by a considerable zone of purple, tender, and undermined skin, which is apt to slough. When healing occurs the skin puckers and usually inverts.

Tuberculosis of Subcutaneous Connective Tissue.

—In this form of tuberculosis nodules of granulation-tissue form and break down (tubercular abscesses). In the deeper tissues these abscesses are usually associated with bone-, joint-, or lymphatic-gland disease (see Cold Abscess, p. 134).

Tuberculosis of the Mammary Gland.—(See p. 137).

Pulmonary Tuberculosis.—In adults the lungs are more commonly affected than any other structure. The lung affection may be primary or may be secondary to some distant tubercular process. Pulmonary tuberculosis belongs to the province of the physician and requires no description here.

Tuberculosis of the Alimentary Canal.—A tubercular ulcer of the lip occasionally occurs, and may be mistaken for a cancer or a chancre. A tubercular ulcer of the tongue is commonly associated with other foci of disease. Such ulcers are separated from cancer by their soft bases and edges and by the rarity of glandular enlargements, and from syphilitic processes by the therapeutic test. Confirmation of the diagnosis is obtained by cultivations and inoculations. Tubercle may affect the pharynx, palate, tonsils, and very rarely the stomach. It is thought that the acid gastric juice must protect the stomach from tubercle, because tubercle bacilli are frequently introduced into the stomach, but the organisms very rarely lodge and multiply in the stomach-wall.

Intestinal tuberculosis may follow pulmonary tuberculosis, but it may arise primarily in the mucous membrane of the bowel or result from tubercular peritonitis. Intestinal tuberculosis causes diarrhea and fever, may resemble appendicitis, and may cause abscess and perforation. Fistula in ano is frequently tubercular, and when it is the lungs are very often involved, the pulmonary lesion being usually primary.

Tuberculosis of the Liver.—Tubercular disease of the liver causes cold abscess or cirrhosis.

Peritoneal tuberculosis may be primary, infection having been by way of the blood, may be part of a diffused process, or may follow intestinal tubercle, the serous and muscular coats of the bowel having been at some point in contact or a follicular ulcer having perforated (Abbe). The germ may have entered by the Fallopian tube. It may be due to ovarian or Fallopian tuberculosis, or to ulceration of a tubercular appendix. It usually causes ascites, tympany, and tumor-like formations composed of adherent bunches of bowel or omentum or distended mesenteric glands.

The **pericardium** may be attacked with primary tuberculosis, or the process may be secondary to pleural tuberculosis.

Tuberculosis of the pleura is not uncommon. Tubercular pleurisy may be acute or chronic. In some instances mixed infection takes place and suppuration occurs. The tuberculosis may be primary, but is usually secondary to pulmonary tuberculosis, and may be due to direct extension or to the rupture of an area of pulmonary softening.

Tuberculosis of the brain induces meningitis and hydrocephalus (p. 674).

Tubercular disease of bone is very common in youth, and is usually preceded by a sprain or a contusion, which is oftener slight than severe. The injury establishes a point of least resistance, and in the damaged area the bacilli are deposited and multiply. The organisms may be deposited directly from the blood, or may arrive in an embolism from a distant tubercular focus (lung or lymph-gland), which embolus is caught in a terminal artery in the end of a long bone and causes a wedge-shaped infarction (Warren).

Tubercular osteitis, as a rule, begins just beneath the articular cartilage or in the epiphysis (Warren). The products of the tubercular inflammation may be absorbed, may be encapsuled by fibrous tissue, or may caseate.

Tubercular disease of the joints is called "white swelling" and also pulpy degeneration of the synovial membrane. Joints are especially liable to tuberculosis in youth, although the wrist and shoulder not infrequently suffer in adult life. Joint-tuberculosis is often preceded by an injury. The tubercular process may begin in the synovial membrane. Primary synovial tuberculosis is most often met with in the knee-joint. Usually the disease begins in the head of a bone, dry caries resulting, necrosis ensuing, or an abscess forming which may break into the joint.

Tuberculosis of lymphatic glands is known as "tubercular adenitis." It is the most typical lesion of scrofula. The common antecedent of a tubercular adenitis of the neck is slight glandular enlargement as a result of catarrhal inflammation of the mucous membrane of the mouth. Tubercular adenitis is most frequent between the third and fifteenth years. A person not of the tubercular type may acquire tuberculosis of the glands, but the disease is unquestionably of much greater frequency in those who are recognized as predisposed to tuberculosis. Tubercular glands may get well, may even calcify, but usually caseate if left alone. After healing they may break down and soften (residual

abscess). They very frequently suppurate because of mixed infection. Though at first a local disease, tubercular glands may prove to be a dangerous focus of infection, furnishing bacteria which are carried by blood or lymph to distant organs or throughout the entire system. Glandular enlargement is in rare instances widely diffused, but it is far more commonly localized. Enlargement of the cervical glands is most common. Tubercular disease of the mesenteric glands causes tabes mesenterica.

Cervical lymphadenitis may be confused with lymphadenoma. The former, as a rule, first appears in the submaxillary triangle, the latter in the occipital or sternomastoid glands. Tubercular glands weld together, they are apt to remain localized for a considerable time, and they tend to soften. They may be accompanied by other tubercular manifestations. Lymphadenoma from the start affects many glands, it may be in several regions, although in some cases there is a distinct beginning in one region. Lymphadenoma shows very little tendency to suppurate and does not break down except late in the course of the disease, and is accompanied by great debility and anemia. Malignant gland-tumors infiltrate adjacent glands and other structures, binding skin, muscles, and glands into one hard, firm mass.

Tuberculosis of the Kidney (page 958).—Tuberculosis may affect the ureter, bladder, prostate gland, seminal vesicles, urethra, Fallopian tube, ovary, and uterus.

Tuberculosis of the Testicle.—This disease is not rare. It is rarely primary, being usually preceded by tuberculosis of the kidney, bladder, or prostate. But one testicle is affected in the beginning, but the other gland is apt to be attacked later. The disease appears as a painless nodule in the epididymis, and as the testicle and the vaginal tunic become involved a hydrocele forms. The tubercular mass softens, becomes adherent to the scrotum and breaks or bursts, exposing the damaged testicle (fungus of the testicle). The cord is always involved in tuberculosis of the testicle.

Diagnosis of Surgical Tuberculosis.—The diagnosis may be determined by purely clinical facts. It may require the use of the microscope, cultivation-experiments, or inoculations. In a suspected tubercular lesion remove a portion of the tissue if it be accessible (by Mixter's cannula), and make sections, stains, and cultivations. If no bacilli are found, inoculate a guinea-pig with the suspected material. If it be tubercular, the animal will develop miliary tuberculosis in a few weeks.

Prognosis.—The prognosis varies with the age, sex, duration, extent, and situation of the lesion. The prognosis is best in children, and is better in males than in females. Tuberculosis of the skin gives a fair prognosis. Tubercular adenitis is often cured. Any tubercular lesion is, however, a menace to the organism, and tends strongly to recurrence.

Treatment.—Destroy the bacilli present and radically remove infected areas which are accessible. Never be satisfied with the removal of part of a diseased focus. Incomplete operations are apt to be followed by diffuse tuberculosis, because many pathways, vascular and lymphatic, are opened to infection. Among the many drugs which have been recommended for local use we mention the following: iodin, carbolic acid, guaiacol, arsenous acid, corrosive sublimate, chlorid of zinc (Lannolongue), phosphate of iron, balsam of Peru (Landerer), camphorated naphtol, oil of cinnamon, cinnamic acid (Landerer), and iodoform.[1] Iodoform used locally upon or in tubercular areas is of great value, and there is no drug which takes its place. Lupus may be treated by the application of blue ointment; by curetting, cauterizing with carbolic acid, and dressing with iodoform; by excision, followed in some instances by sliding in of a flap of sound tissue or immediate skin-grafting. If treating a nodular and non-ulcerated area, wash it with a 2 per cent. solution of corrosive sublimate and inject several nodules with camphorated naphtol, one drop for each nodule. In seven or eight days inject other nodules, and so on. Koch's lymph has cured some cases of lupus. Enlarged glands of uncertain character and very recent tubercular enlargements should be treated by rubbing ichthyol into the skin over the glands and treating the patient hygienically, and by the internal administration of antitubercular drugs. If this plan fails to cure, the glands should be removed. When glands break down they should be removed, or should be opened, curetted, and packed. The rule must be to completely dissect out enlarged lymphatic glands which fail to quickly respond to treatment, removing capsules and glands. In any tubercular trouble climate is of very great importance. Osler sums up climatic necessities as "pure atmosphere, equable temperature, and maximum amount of sunshine." Open-air life is imperative. The patient must have a well-ventilated sleeping-room, and his house should be free from dampness. Nourishing diet is essen-

[1] See article upon "Tuberculosis," by George Ryerson Fowler, *Brooklyn Med. Jour.*, Nos. 8 and 9, 1894.

tial. To secure a gain in weight is a constant aim. Give meat, milk, cream, butter, and cod-liver oil. The oil is poorly borne in hot weather, during which period it should be discontinued. Advancing doses of beechwood, creasote, guaiacol carbonate, arsenic, quinin, and stimulants have their uses. (For treatment of tuberculosis of bones, joints, peritoneum, pleura, etc., look under special regional headings.)

Bier's Method.—A few years ago Bier set forth a new plan for treating tubercular lesions. It consists in causing venous obstruction and passive congestion. In the area of passive congestion the tissue-cells form antitoxins which kill the bacteria or attenuate their virulence. The treatment is founded upon the principle announced by Laennec, that "cyanosis is antagonistic to tubercle." The plan is applied particularly in joint-tuberculosis. An elastic band three inches broad is placed around the limb, above the seat of disease, and it is applied sufficiently tight to cause congestion. Several pieces of lint ought to be interposed between the skin and the band. By applying a flannel bandage from the periphery to the lower border of the disease the congestion is limited to the area of trouble. The patient should wear the band continually and move about with it on. Some people wear it without any inconvenience, but others complain greatly after wearing it but a short time. Bier and others have reported cures.

Koch's Tuberculin.—The specific treatment by Koch's tuberculin or paratoloid has excited widespread interest. It has not fulfilled the expectations which many entertained, but does benefit some cases, notably lupus. A serious drawback to the value of Koch's tuberculin is that it often causes fever and inflammation to a dangerous degree. In some cases, as Virchow showed, it produces acute miliary tuberculosis. Koch's lymph is a glycerin-extract of a culture of tubercle bacilli, and the usual dose is 1 milligram, given hypodermatically into the back by Koch's pistonless syringe. After it has been used for a time the dose may be increased to 10 milligrams, or even much more. Bergmann gave 1 gram. Koch's lymph causes inflammation and necrosis of tubercular tissue by the action of certain antitoxins. Many cases it improves. Some cases it apparently cures, but the disease is apt to return. In pulmonary tubercle it must not be given if there be much fever or extensive consolidation. Chiene used tuberculin largely in joint-cases by giving two or three doses a day and increasing the dose. It is best to associate other treatment with the lymph. Tuberculin may

be used for diagnostic purposes in animals. If tuberculosis exists, an injection of tuberculin produces a marked reaction. Czerny has shown that in renal tuberculosis in a human being bacilli are often absent from the urine, but an injection of tuberculin will cause bacilli to appear plentifully. Koch has recently modified his tuberculin. He makes it as follows: dried cultures of bacilli are mixed with distilled water, and the mixture is agitated in a centrifuge. Two layers separate. The upper layer is the old tuberculin. The lower layer is the new tuberculin. The new tuberculin is given hypodermatically, at first in very small doses, but finally in doses as large as 20 milligrams. It is not to be given in far advanced cases or cases with much fever.

Hunter, of London, declares that Koch's old lymph contains one principle which causes fever, another which causes inflammation, and a third which produces atrophy of tubercular foci without either fever or inflammation. This third desirable element he believes he has isolated in what is called a "derivative of tuberculin," a modified lymph. Some remarkable results have followed the use of this material; its administration seems entirely safe, and it should thoroughly and carefully be tried to ascertain its true rank as a remedy. The injection of serum obtained from animals refractory to tubercle has been employed, but Richet and Hericourt have seen no benefit from the plan. Maragliano, of Genoa, uses a serum which he believes can cure tuberculosis. He immunizes animals not by injection of living cultures, but by employing the toxic principles extracted from them. Progressive vaccinations immunize a dog. The serum of the animal is injected for the cure of tuberculosis in man or other animals. If injected along with tuberculin, it neutralizes the general and local reaction of the latter agent. The serum has apparently benefited some cases, but is certainly useless against mixed infections.[1]

XIV. RHACHITIS, OR RICKETS.

Rickets is a constitutional disease arising during the early years of life (the first two or three) as a result of insufficient or of improper diet and bad hygienic surroundings. A deficiency of fat and phosphate in the food or the use of a diet which, by inducing gastro-intestinal catarrh, prevents assimilation, causes rickets. The disease is never congenital, the so-called "congenital rickets" being sporadic cretinism (Bowlby).

[1] *Brit. Med. Jour.*, 1895, ii. 444.

Evidences of Rickets.—The condition is one of general ill-health; the child is ill-nourished, pallid, flabby; it has a tumid belly and suffers from attacks of diarrhea and sick stomach; it is disinclined for exertion and has a capricious appetite; it is liable to night-sweats and night-terrors; enlarged glands are often noted, the teeth appear behind time, and the fontanels close late. The long bones become much curved, the upper part of the chest sinks in, curvature of the spine appears, the head is large and the forehead bulges, and the pelvis is distorted. Swelling appears in the articular heads of long bones, by the side of the epiphyseal cartilages, and in the sternal ends of the ribs, forming in the latter case rhachitic beads. The lesions of rickets are due to imperfect ossification of the animal matter which is prepared for bone-formation, and the soft bones gradually bend. The swellings at the articular heads are due to pressure forcing out the soft bone into rings. Rhachitic children rarely grow to full size, and the disease is responsible for many dwarfs. Most cases recover without distinct deformity, but the time lost during the period when active development should have gone on cannot be made up, and some slight deficiency is sure to remain. Bowlegs, knock-knees, and spinal curvatures are usually rhachitic in origin. The disease may be associated with scurvy, inherited syphilis, or tuberculosis.

Treatment.—The treatment consists in having the child live as much as possible in the open air and sunshine. Salt-water baths are useful. Sea-air is very beneficial. Fresh food (milk, cream, and meat-juice) should be ordered. Cod-liver oil, syrup of the iodid of iron, arsenic, and some form of phosphorus are to be administered. It is absolutely necessary to improve the primary assimilation.

Scurvy.—This disease is rare to-day in adults, but was at one time very common among those who took long voyages, or who engaged in campaigns, or were the victims of sieges. Of recent years it is very uncommon, and has occurred chiefly among voyagers in the Arctic regions.

It is a constitutional malady due to the consumption of improper diet, and especially to the employment of a diet characterized by the absence of vegetables.

The use of salt meat as a staple article seems to favor the production of the disease. Garrod considered absence of potassium salts to be the real cause. Absence of variety in diet, bad water, poorly ventilated quarters, and insufficient exercise favor the development of the disease.

The disease begins with weakness, drowsiness, muscular

pains, and great susceptibility to cold. The skin is pallid or dirty white, and is occasionally mottled and often peels off. The pulse is excessively weak and slow. There is no fever. After two or three weeks the gums become tender, painful, and swollen, and bleed at frequent intervals; the breath becomes offensive, the teeth loosen and even drop out; subcutaneous hemorrhages take place, giving rise to petechiæ or extensive extravasations; the vision becomes dim; the urine becomes scanty and of low specific gravity; vesicles form, rupture, and give rise to bleeding ulcers, and ulcers likewise arise from breaking down of blood extravasations;[1] hemorrhages take place into and between the muscles, and in severe cases beneath the periosteum and into joints, and blood may flow from the nose, lungs, kidneys, stomach, and intestines. Deep hemorrhages are felt as hard lumps. Bleeding at an epiphyseal line may separate the epiphysis from the shaft. If an inflammation or ulceration arises at any point, fever is observed. It was observed by DeHaven in the Grinell expedition in search of Sir John Franklin that scurvy causes old and soundly healed wounds to ulcerate. Most cases get well under proper treatment, but complete recovery is not attained for a long time. It is important to remember that though scurvy is rare in adults, it is by no means uncommon in ill-nourished infants. The author has seen two cases, in one of which a large subperiosteal hemorrhage was mistaken for sarcoma of the femur. Infantile scurvy may exist with rickets.

Treatment.—Give vinegar, lemon-juice, onions, scraped apples, cider, nitrate of potassium, antiseptic mouth-washes, strychnin, plenty of nourishing food, and whiskey or brandy. Secure sleep and treat the ulcers by antiseptic dressings and compression.

Scurvy can be prevented entirely by employing a proper diet, and maintaining cleanliness and hygienic conditions.[2]

The following agents are believed to be especially useful as preventatives: fresh meat, lemon-juice, cider, vinegar, milk, eggs, onions, cranberries, cabbages, pickles, potatoes, and lime-juice.

Infantile scurvy may exist alone or with rickets. It occurs most often in the children of the well-to-do, those who have been brought up on artificial foods. It occurs between the eighth and eighteenth months. The child is anemic, suffers from gastro-intestinal disorders, spongy gums, weak-

[1] *American Text-Book of Surgery.*
[2] *Ibid.*

ness of the legs, general muscular tenderness, night-sweats, and often febrile attacks (Rotch). There may be bleeding beneath the skin (blue spots), bloody urine and stools, bleeding into joints, viscera, or muscles. A subperiosteal hemorrhage is very dense, is tender, is fusiform in outline, and does not fluctuate. It is sometimes mistaken for sarcoma. The limb attacked is flexed, and the child will not move it. Separation of an epiphysis may result from hemorrhage between it and the bone.

Treatment.—Give orange-juice, grape-juice, meat-juice, scraped apples, potatoes, nourishing food, tonics, and antiseptic mouth-washes.

XV. CONTUSIONS AND WOUNDS.

Contusions.—A contusion or bruise is a subcutaneous laceration, the skin above it being uninjured or damaged without a surface-breach and blood being effused. In intra-abdominal contusions the skin of the abdomen is frequently not damaged. In contusion of structures overlying a bone the skin suffers with the deeper structures. If a large vessel is ruptured, hemorrhage is profuse and much blood gathers in the tissue. If only small vessels suffer, hemorrhage is moderate. An *ecchymosis* is diffuse hemorrhage over a large area, the blood lying in the spaces of the subcutaneous or submucous areolar tissue. A *hematoma* is a blood-tumor or a circumscribed hemorrhage, the blood lying in a distinct cavity in the tissues. A very small ecchymosis is known as a petechia; a very large ecchymosis is called a suffusion or extravasation. In very severe contusions, tissue vitality may be destroyed or so seriously impaired that gangrene follows. Suppuration rarely occurs, but occasionally does so, and is most apt to in drunkards or those of dilapidated constitution. When hemorrhage arises in the tissues after a contusing force it soon ceases unless a very considerable vessel is ruptured. The arrest of hemorrhage is brought about by the resistance of the tissues, the contraction and retraction of the vessels, by coagulation of blood, and in some cases of severe injury coagulation is favored by syncope (page 327). Blood in the tissues, as a rule, soon coagulates, the fluid elements being absorbed and the red corpuscles breaking up and setting free pigment, which pigment may be carried away from the seat of injury or may crystallize and remain there as hematoidin. In some cases inflammation occurs about the extravasated blood, a capsule of fibrous

tissue being formed, and the blood being slowly absorbed, or the fluid elements remaining unabsorbed (blood-cyst), or the blood becoming thicker and thicker, finally calcifying. Blood in serous sacs (joints, pleura, pericardium) coagulates very slowly. As blood is being absorbed it undergoes chemical changes and color-changes ensue, the part being at first red and then becoming purple, black, green, lemon, and citron. The stain following a contusion is most marked in the most dependent area. After a bruise of the periosteum a blood-clot forms, much tissue-induration occurs, and a hard edge can be detected by palpation.

Symptoms.—The symptoms are tenderness, swelling, and numbness, followed by some aching pain or a feeling of soreness. The pain rarely persists beyond the first twenty-four hours. Discoloration appears quickly in superficial contusions, but only after days in deep ones. In some regions, the scalp, for instance, it can scarcely be detected; in others, as in the eyelid and vulva, discoloration is early, widespread, and marked. Discoloration is very marked in regions where loose cellular tissue abounds (eyelids, prepuce, scrotum). The discoloration is at first red, and becomes successively purple, black, green, lemon, and citron. The swelling is first due to blood, and is added to by inflammatory exudation. In a more severe contusion a hematoma may form. In the skin over a superficial hematoma there is discoloration; in the skin over a deep hematoma there is no discoloration. A recent hematoma fluctuates, but gradually, because of cell-proliferation, the edge becomes hard and the center continues to fluctuate. The mass gradually grows smaller and finally disappears. A hematoma of the scalp may be mistaken for depressed fracture of the skull (p. 658). It may also be mistaken for an abscess, but differs from it in the absence of inflammatory signs. It occasionally, though rarely, suppurates. In a case in which suppuration occurs an abrasion, which may be very minute, often exists on the skin. In any severe contusion there is considerable and possibly grave, or even fatal, shock.

Treatment.—In a severe injury bring about reaction from the shock. Local treatment consists in rest, elevation, and compression to arrest bleeding, antagonize inflammation, and control swelling. Cold is useful early in most cases, but it is not suited to very severe contusions nor to contusions in the debilitated or aged, as in such cases it may cause gangrene. In very severe contusions employ heat and stimulation. When inflammation is subsiding after a contusion, massage and inunctions of ichthyol should be employed. Massage

and passive motion are imperatively needed after contusion of a joint. A contusion should never be incised unless the amount of blood is large and a distinct cavity exists, or hemorrhage continues, infection takes place, a lump remains for some weeks, or gangrene is threatened. If the amount of blood is very large and a distinct cavity exists, aspiration or incision lessens the danger of fat-embolism. For persistent bleeding freely lay open the contused area, turn out clots, ligate vessels, insert drainage-strands or a tube, and close the wound. If gangrene is feared, make incisions and apply heat to the part. If a slough forms, employ antiseptic fomentations. The constitutional treatment for contusion, after the patient has reacted from shock, is the same as that for inflammation.

Wounds.—A wound is a breach of surface-continuity effected by a sudden mechanical force. Wounds are divided into open and subcutaneous, septic and aseptic, incised, contused, lacerated, punctured, gunshot, and poisoned.

The **local phenomena of wounds** are pain, hemorrhage, loss of function, and gaping or retraction of edges.

Pain is due to the injury of nerves, and it varies according to the situation and the nature of the injury. It is influenced by temperament, excitement, and preoccupation. It may not be felt at all at the time of the injury. At first it is usually acute, becoming later dull and aching. In an aseptic wound the pain is usually slight, but in an infected wound it is always severe.

The nature and amount of *hemorrhage* vary with the state of the system, the vascularity of the part, and the variety of injury.

Loss of function depends on the situation and extent of the injury.

Gaping or *retraction of edges* is due to tissue-elasticity, and varies according to the tissues injured and the direction, nature, and extent of the wound.

The **constitutional condition** after a severe injury is a state known as *shock*, which is a sudden depression of the vital powers arising from an injury or a profound emotion acting on the nerve-centers and inducing vasomotor paresis and paralysis of the sympathetic in the abdomen, the blood accumulating in the abdominal vessels and the amount of circulating blood being much diminished. In shock the abdominal veins are greatly distended and the other veins of the body may also be overfull, the arteries contain less blood than normal, and an insufficient amount of blood is sent to

the vital centers in the brain. The term collapse is used by some to designate a severe condition of shock, and is employed by others as a name for a condition of shock produced by mental disturbance rather than by physical injury. Shock may be slight and transient, it may be severe and prolonged, and it may even produce almost instant death. Sudden death from shock is due to reflex stimulation of the pneumogastric nuclei and arrest of cardiac action. It is known as death by inhibition. Shock is more severe in women than in men, in the nervous and sanguine than in the lymphatic, in those weakened by suffering than in those who are strangers to illness. It is predisposed to by fear, by disease of the kidneys, diabetes, chronic cardiac disease, and alcoholism. Injuries of nerves, of the intrathoracic viscera, of the intra-abdominal viscera, of the urethra, or of the testicle produce extreme shock. Anything which extracts the body-heat favors the development of shock (exposure to cold air, insufficient covering, chilling the body by solutions or wet towels). Cerebral concussion is shock plus other conditions. Sudden and profuse hemorrhage causes shock; so does prolonged anesthetization. Great shock may occur after the removal of a large tumor or a quantity of fluid from the abdomen. In such a case shock is brought about by the sudden removal of pressure and the consequent rapid distention of intra-abdominal veins.

Symptoms.—The symptoms of ordinary shock (torpid or apathetic shock) are subnormal temperature; irregular, weak, rapid, and compressible pulse; cold, pallid, clammy, or profusely perspiring skin; shallow and irregular respiration; and a tendency to urinary suppression. Consciousness is usually maintained, but there is an absence of mental originating power, the injured person answering when spoken to, but volunteering no statements and lying with partly closed lids and expressionless countenance in any position in which he may be placed. The pupils are dilated and react but slowly to light. The sphincters are relaxed. Pain is slightly or not at all appreciated. Nausea is absent and vomiting may, as in concussion, presage reaction. Gastric regurgitation, after a considerable duration of shock is not unusual, and is a bad omen. Shock is not rarely followed by suppression of urine. Whereas the victim of shock is usually stupid and indifferent, he may become delirious. If delirium arises, the condition is very grave. Travers called shock with delirium erithistic or delirious shock. As a matter of fact, such a state is not genuine shock, but is

either a traumatic or a toxic delirium. It is usually due to uremia or sepsis. Delirious shock arises after a person has been bitten by a poisonous snake. Many years ago Travers described a secondary or delayed form of shock, which comes on several hours after an injury or violent emotional disturbance. This form of shock is seen not unusually in those who have passed through a railroad accident. It may be a sign of hemorrhage, and is sometimes met with after the administration of ether or chloroform.

Diagnosis.—Concealed hemorrhage is difficult to separate from shock. It produces impairment of vision (retinal anemia), irregular tossing, frequent yawning, great thirst, nausea, and sometimes convulsions. In shock the hemoglobin is unaltered; in hemorrhage it is enormously reduced (Hare and Martin). In hemorrhage recurrent attacks of syncope are met with. In pure shock such attacks do not occur. In concealed hemorrhage the abdomen may exhibit physical signs of a rapidly increasing collection of fluid. Shock and hemorrhage are often associated. The essential characteristic of shock is sudden onset, which separates it distinctly from exhaustion. It arises at a much earlier period after an injury than does fat-embolism.

The Prevention of Shock in Operations.—Examine the patient with care before operating, giving special attention to the condition of the kidneys. If the condition of the patient leads us to fear that there will be dangerous shock, do not purge him severely before operation, and just previous to operation give a rectal injection of hot saline fluid. It is a good plan in such cases to give a hypodermatic injection of gr. $\frac{1}{8}$ of morphin twenty minutes before operation. Give as little ether as possible. Cover every part but the field of operation with hot blankets and put cans of hot water about the patient, or put him on a bed composed of hot-water pipes covered with blankets. Operate as rapidly as is consistent with safety and thoroughness.

Treatment.—In treating ordinary apathetic shock raise the feet and lower the head, unless this position causes cyanosis. At least place the head flat and the body recumbent. Wrap the patient in hot blankets and surround him with hot bottles, hot bricks, hot-water bags, or cans of hot water. Always wrap a can, a bottle, or a bag in flannel, to avoid burning the patient. Give hypodermatic injections of ether, brandy, strychnin, digitalis, or atropin, or inhalations of amyl nitrite. Strychnin can be used in large doses; gr. $\frac{1}{30}$ can be given every ten or fifteen minutes until three doses have been taken.

If the skin is very moist, atropin is indicated; it can be given alone or combined with strychnin. Senn recommends the hypodermatic injection of sterile camphorated oil, a syringeful every fifteen minutes until reaction begins. Inhalation of oxygen is often of much service, and artificial respiration may be necessary. Opiates are contraindicated in shock. Mustard plasters should be placed over the heart, spine, and shins. The use of hot and stimulating rectal enemata is very important. The rectum may absorb fluids when the stomach refuses to do so. Enemata of hot normal salt solution are very beneficial (enteroclysis). The tube is carried into the sigmoid flexure and the injection is introduced so as to distend the colon. A turpentine enema is useful. An enema of hot coffee and whiskey is very valuable. In severe cases of shock bandage the extremities. Bandaging for the relief of shock is called autotransfusion. This procedure enables the body to utilize to the best advantage the small amount of circulating blood, and send most of it to the brain, where it will maintain the activity of the vital centers and keep up circulation and respiration. For this purpose ordinary muslin bandages may be used, or gauze bandages, or the bandages of Esmarch. Abdominal massage helps drive out the imprisoned blood, and after massage sets free the abdominal blood apply a compress and binder. Hypodermoclysis is of great value. Insert an aspirator-tube into the cellular tissue of the buttock, loin, or scapular region, cleansing the part first. The tube is attached to a fountain-syringe, which is filled with normal salt solution, and is hung at a height of two or three feet above the bed. In an hour's time a pint or more of fluid will enter the tissue and be absorbed. In very dangerous cases infuse salt solution into a vein, make artificial respiration, and stimulate the diaphragm with a galvanic current. If shock comes on during an operation, the operation must be hurried or even stopped, and proper treatment must be instituted at once. The anesthetizer should give very little ether when shock becomes at all evident. Should we operate during shock? We should only do so when death without instant operation is inevitable. We must operate, if it is necessary to do so, to arrest hemorrhage, to relieve strangulated hernia, intestinal obstruction, obstruction of the air-passages, compound fractures of the skull, extravasated urine or intraperitoneal extravasations from ruptured viscera. If hemorrhage can be temporarily controlled by pressure or a clamp, so much the better, and the permanent arrest can be

effected after the reaction from shock. It is not wise, in the author's opinion, to amputate during shock. A tourniquet or Esmarch bandage should be applied, and attempts be made to bring about reaction, and when reaction is obtained the amputation should be performed. It is only just to say that some eminent surgeons oppose this rule. Roswell Park says that " shock is often alleviated by the prompt removal of mutilated limbs which, when still adherent to the trunk, seem to perpetuate the condition." The same teacher believes in operating at once upon severe compound fractures.[1] After every operation keep careful watch upon the amount of urine passed, see to it that the patient takes sufficient fluid, and if the urine becomes scanty put a hot-water bag over the kidneys, give diuretics and hot saline enemata. If the condition is not soon benefited, infuse hot saline fluid into a vein. Post-operative suppression of urine is almost invariably fatal. Delayed shock is treated in the same manner as apathetic shock if hemorrhage can be excluded. If hemorrhage is the cause, the bleeding must be stopped. If delirious shock is due to sepsis, the treatment is that of sepsis. If it is a nervous delirium, give morphin and other sedatives. If due to uremia the treatment is obvious.

Fat-embolism.—(See p. 172.)

Fever.—(See Fevers, p. 115.)

Treatment of Wounds.—All wounds, other than those made by the surgeon, are regarded as infected. The rules for treating such wounds are—(1) arrest hemorrhage; (2) bring about reaction; (3) remove foreign bodies; (4) asepticize; (5) drain, coaptate the edges, and dress; and (6) secure rest to the part and combat inflammation. Constitutionally, allay pain, secure sleep, maintain the nutrition, and treat inflammatory conditions.

Arrest of Hemorrhage.—To arrest hemorrhage the bleeding point must be controlled by an Esmarch band or digital pressure until ready to be grasped with forceps; it is then caught up and tied with catgut or aseptic silk. Slight hemorrhage stops spontaneously on exposure to air, and moderate hemorrhage ceases after the vessels are clamped for a time. An injured vessel when not of the smallest size must be ligated, even if it has ceased to bleed. Capillary oozing is checked by hot water and compression. If a large artery is divided in a limb, apply a tourniquet before ligating (see Wounds of Vessels).

Bringing about of Reaction.—(See Shock.)

Removal of Foreign Bodies.—Remove all foreign bodies

[1] Park's *Surgery by American Authors.*

visible to the eye (splinters, bits of glass, portions of clothing, gun-wadding, grains of dirt, etc.) with forceps and a stream of corrosive-sublimate solution, sterile water, or normal salt solution. In a lacerated or contused wound portions of tissue injured beyond repair should be regarded as foreign bodies and be removed with scissors.

Cleaning the Wound.—To clean the wound scrub the area around it with ethereal soap, green soap, or castile soap, wash with water, scrub with alcohol, and then with corrosive-sublimate solution (1 : 1000). If the surface is hairy, it must be shaved before the scrubbing. An accidental wound is infected, and must be well washed out with an antiseptic solution. A clean wound made by the surgeon need not be irrigated; in fact, irrigation with an antiseptic fluid leads to necrosis of tissues, causes a profuse flow of serum, and necessitates drainage. If clots have gathered in a wound, they must be removed, as their presence will prevent accurate coaptation of the edges. In an infected wound they are washed out with a stream of corrosive-sublimate solution. In a clean wound they are washed out with hot salt solution. If dirt is ground into a wound, as is often seen in crushes, pour sweet oil into the wound, rub it into the tissues, and scrub the wound with ethereal soap. The oil entangles the dirt, and the soap and water remove both oil and dirt. After the rough cleansing irrigate with corrosive-sublimate solution. In some cases, especially in bone-injuries, it is necessary to scrape the wound with a curet. If a fissure of the skull is infected, enlarge the fissure with a chisel in order to clean it. In a badly infected wound one of the most valuable agents for use in producing disinfection is pure carbolic acid. After cleaning the wound, it is necessary in certain regions to examine in order to determine if tendons or considerable nerves have been cut. If such structures have been divided, they must be sutured with fine silk, chromic gut, or kangaroo-tendon.

Drainage, Closure and Dressing.—Superficial wounds require no special drainage, as some wound-fluid will find exit between the stitches and the rest will be absorbed. A large or deep wound requires free drainage for at least twenty-four hours by means of a tube, strands of horse-hair, silk, or catgut, or bits of iodoform gauze. An infected wound must invariably be drained. Good drainage may, to a considerable extent, compensate for imperfect antisepsis. If capillary drains be employed, apply a moist dressing. Approximate the edges with interrupted sutures of silk or silkworm-gut if the wound is deep and considerable tension is inevitable.

Catgut is used for superficial wounds and for those where tension is slight. If there is decided tension, silver wire may be used. In very deep wounds buried sutures must be used. These sutures may consist of absorbable material (kangaroo-tendon or catgut) or unabsorbable material (silver wire). If the wound is infected, dress with moist antiseptic gauze. If it is not infected, dress it with dry sterile gauze. The custom once was to cover the gauze with a rubber-dam to diffuse the fluids, but we now prefer to omit the rubber-dam and use plentiful dressings. A dry dressing absorbs wound-fluids quickly and is less likely to become infected. Change the dressings in twenty-four hours, or sooner if they become soaked with discharge. Dressings are changed for cause, but not according to scheduled time. They must, of course, be changed when they become soaked with wound-fluid, and soaking may occur in a few hours, but may not occur for days. As long as temperature remains good, the wound free from pain, and the dressing not wet with discharge, it can be left in place unless removal is necessary to take out a drainage-tube. If pus forms, open the wound at once. Many surgeons sprinkle wounds before approximation and wound-surfaces after approximation with a drying-powder. These powders are of great use in infected wounds, but are not necessary in clean wounds. Among the substances employed are salicylic acid, boracic acid, calomel, acetanilid, aristol, iodoform, subiodid of bismuth, and glutol. In large wounds which cannot be approximated, it is occasionally advisable to skin-graft by Thiersch's method. A small wound which cannot be sutured is dusted with an antiseptic powder and dressed. A granulating wound is dressed as is a healing ulcer. A sloughing wound is opened, is dusted with iodoform or acetanilid, and is dressed with hot antiseptic fomentations.

Rest.—Severe wounds require the confinement of the patient to bed. Bandages, splints, etc., are used to secure rest. The methods of combating inflammation have previously been set forth.

Constitutional Treatment.—Bring about reaction from depression, but prevent undue reaction. Feed the patient well, stimulate him if necessary, attend to the bowels and bladder, secure sleep, and allay pain. Watch for complications, namely, inflammation, suppuration, gangrene, tetanus, and erysipelas. Observe the temperature closely; it may be a danger-signal of urgent importance.

Incised Wounds.—An incised wound is a clean *cut* in-

flicted by an edged instrument. Only a thin film of tissue is so devitalized that it must die. These wounds have the best possible chance of union by first intention.

The pain may be very severe; but if the instrument is sharp and used quickly it may be trivial. The pain is less severe than that caused by some other varieties of wounds. The acute pain does not last long, and is followed by smarting. The hemorrhage is profuse, varying, of course, with the region cut. Bleeding from the scalp is violent, because there are numerous vessels which lie in fibrous tissue and cannot retract nor contract. The edges of incised wounds retract because of tissue-elasticity, and the wound "gaps." If the skin or fasciæ are divided at a right angle to the muscle beneath, there is wide gaping. If the cut is parallel to the muscle-fibers, the gaping is slight.

When the skin is violently pulled upon, it tends to split in a certain line. Langer and Kocher speak of this as the line of cleavage, and point out the direction of these lines in various situations. A cut across the line of cleavage is followed by wide gaping. A cut in the direction of the line of cleavage produces slight gaping, and is followed by a trivial scar.

When a muscle is cut across, the wound-edges widely separate. When a tendon is completely cut across, extensive separation occurs.

Treatment.—According to general principles arrest hemorrhage and asepticize.

Examine the wound carefully to see if a nerve, a tendon, or a muscle is divided, and if such injury is discovered suture

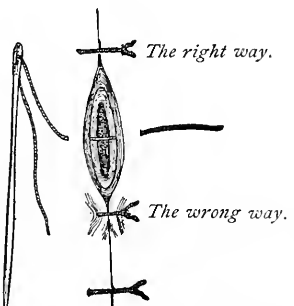


Fig. 55.—The interrupted suture (after Bryant).

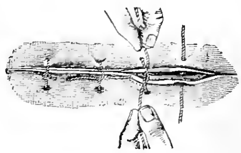


Fig. 56.—Interrupted suture.

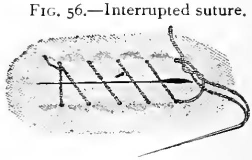


Fig. 57.—Continuous suture.

at once. If the wound is extensive or deep, it may be necessary to use buried sutures in order to keep the sides of the

wound in contact. If the surface of a wound is approximated, but the depths are not, the dead space or cavity

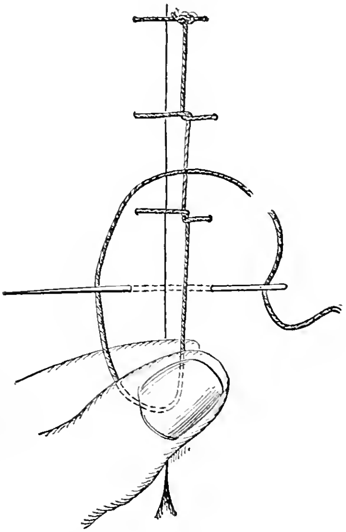


FIG. 58.—Ford's suture: a square knot, a single knot, a double or friction knot, and the first method of passing the needle to tie a single knot immediately.

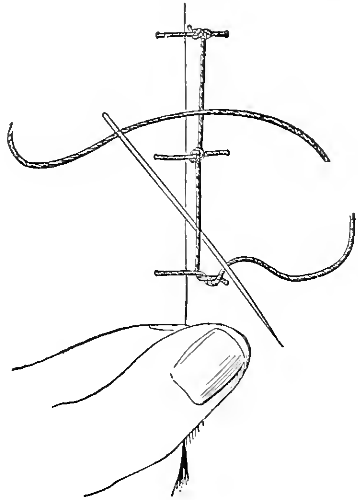


FIG. 59.—Ford's suture: showing two square knots, a single knot, and the method of completing a square knot.

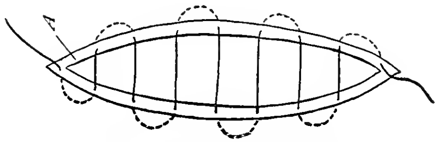


FIG. 60.—Halsted's subcuticular suture.

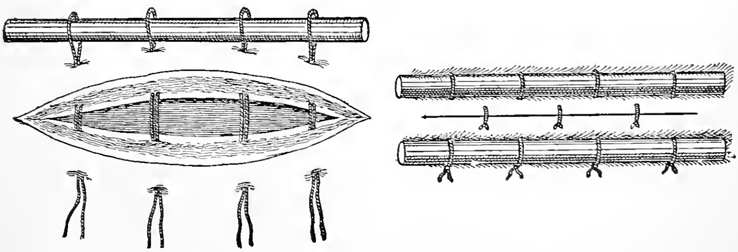


FIG. 61.—The quilled suture.

becomes filled with fluid, and infection almost certainly occurs. If buried sutures have not been used, such a cavity

must be obliterated by the judicious application of pressure upon the surface. This is secured by the adaptation of a mass of loose or fluffed-up gauze, and the firm application of a bandage or binder. An incised wound is usually closed with interrupted sutures (Figs. 55 and 56). In adjusting the sutures, see that the edges of the wound are not inverted, but are neatly adjusted, and that the knot does not lie upon the wound-line, but rests to the side of it. Tie the stitches firmly but not tightly. If a stitch is tied too tightly it will make a furrow, as shown in Fig. 55, and undue tightness is sure to cause necrosis, and is often productive of a stitch-abscess. A silk suture and a catgut suture should be tied with the reef knot; a suture of silkworm-gut should be tied with a surgeon's knot. If a wound is on the face, particular care must be employed in closing it, in order to limit the amount of disfigurement. In a clean wound stitches can, as a rule, be removed in from six to eight days. In a large wound one-half the stitches are removed at one sitting, and in a day or two the rest are removed. Stitches are promptly removed if they begin to cut out or if infection occurs.

The old continued suture (Fig. 57) is rarely used for skin-wounds at the present time. This suture is employed to suture the dura after division, to suture the two layers of pleura together before an abscess of the lung is opened, to suture the peritoneum after laparotomy, and to suture the mucous membrane after certain operations upon the stomach. The continued suture is shown in Figs. 57–59.

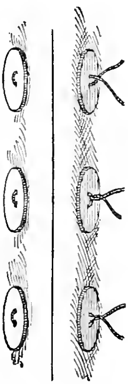


Fig. 62.—Button suture.

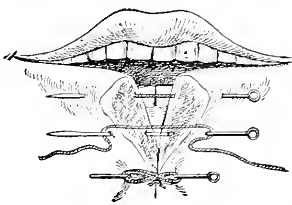


Fig. 63.—The twisted suture.

Halsted's subcuticular stitch (Fig. 60) makes a most perfect closure of the skin-wound, and is followed by the smallest possible scar. It is only used in wounds which are almost certainly clean, as those made by the surgeon, and in wounds which do not require drainage. The suture is of silver wire

caught upon a Hagedorn needle and passed through the corium on each side of the wound, as shown in Fig. 60. The needle must be held in the bite of a needle-holder. When the suture has been passed the ends are pulled upon, and the skin-wound closes neatly.

Halsted's suture does not penetrate the skin; hence, in passing it the white staphylococcus is not carried through stitch-holes and into the wound, an accident which might be followed by infection of a stitch-hole or even of the wound. When it is desired to withdraw this suture, take one end in the bite of a forceps, cut it off short with scissors, and pull steadily upon the other end.

In very deep wounds or wounds in which there is much tension after approximation the quilled suture (Fig. 61), or the button-suture (Fig. 62) may be used. The twisted suture, or harelip suture, is shown in Fig. 63.

Problems of drainage, dressing, etc., are discussed on page 210.

If infection occurs, the wound becomes swollen, tender, painful, and discolored, and the temperature of the patient soon becomes elevated. In such a condition cut the stitches, disinfect, and drain.

Contused and Lacerated Wounds.—A contused wound results from a blow or a squeeze which bruises and crushes the tissues and splits or ruptures the skin. It is a common injury when force is applied to tissues over a bone. The blow of a blackjack will cause either a contusion or a contused wound of the scalp. A contused wound is irregular in outline, with jagged edges, and is surrounded by a broad zone of contusion.

A lacerated wound results from tearing apart of the tissues. It too is irregular and jagged, and is accompanied by more or less contusion. A brush-burn is a contused-lacerated wound due to friction. Both lacerated and contused wounds contain masses of partly detached and damaged tissue, the vitality of which is endangered. Hence, such wounds are apt to slough, frequently suppurate, and are occasionally followed by cellulitis or even by gangrene. There is more danger of tetanus than in incised wounds. In contused and lacerated wounds the edges are discolored and cold to the touch, and there is little primary hemorrhage. There is considerable danger of secondary hemorrhage if large vessels have been bruised. In wounds of this nature the pain is often violent and shock is very severe.

Treatment.—The surgeon endeavors to asepticize the

wound and skin about it (page 210), arrests hemorrhage, and ligates any visible damaged vessel whether it bleeds or not. Hopelessly damaged tissue should be cut away, doubtful tissue being retained. Secure thorough drainage, in some situations making counter-openings if necessary. Tube-drainage may be necessary or iodoform-gauze packing may be used. Contused wounds and lacerated wounds are rarely closed by sutures except when on the face. They are rarely closed because the damage is so great and the blood-supply so interfered with that primary union will not occur. In the face the blood-supply is so good that primary union may be obtained in part or entirely, and it is worth while to try to obtain it. Dress contused and lacerated wounds with moist antiseptic gauze and keep the part at rest. Cold must not be applied to a region of lowered vitality, because it might cause gangrene. Heat is useful. Hence, it is advisable, even from the start, to dress with hot antiseptic fomentations, and this mode of dressing becomes imperative if sloughing begins.

If suppuration occurs, the surgeon sees to it that the pus has free exit, and if necessary secures free exit by making incisions.

Punctured Wounds.—Punctured wounds are made with pointed instruments, as needles, pointed knives, pointed swords, bayonets, splinters, etc. An arrow wound is punctured and incised. The depth of a punctured wound greatly exceeds its surface area. After the withdrawal of the instrument inflicting the injury the wound partly closes at points, blood and wound-fluid cannot find exit, and if, as is probably the case, bacteria were deposited in the tissues, infection with pus organisms is very likely to occur, and if it does occur suppuration spreads widely. There is also danger of infection with tetanus bacilli. Such a wound may involve an important blood-vessel, and in such a case profuse hemorrhage will occur, otherwise hemorrhage is slight. A great cavity of the body may be penetrated or an important organ may be wounded. Large-sized foreign bodies may be driven into the tissues or a portion of the instrument may break off and lodge. Pain is rarely severe unless a considerable nerve has been damaged. If both a large vein and artery are punctured, varicose aneurysm or aneurysmal varix may arise.

Treatment.—If there is severe hemorrhage, enlarge the wound and tie the bleeding vessels. In a puncture not made by the surgeon, the wound must be regarded as infected. It is proper that the skin about it be sterilized, that foreign bodies be removed, that the wound be irrigated with an antiseptic solution, and be drained with a tube or a strip of

gauze. Such treatment though painful, and appearing unnecessarily severe or even cruel to the sufferer from a trivial puncture, is necessary, and may save the patient from serious illness or from death.

Pure carbolic acid is one of the most efficient of agents to sterilize a punctured wound.

If an important cavity of the body has been invaded by a puncture, exploratory incision is necessary (see Brain, Thorax, Abdomen). An arrow should not be pulled out, but it should be pushed through; or if its situation renders such a procedure improper, it must be cut down upon and withdrawn.

Gunshot-wounds.—Gunshot-wounds are contused or contused-lacerated wounds inflicted by materials projected by explosives. A bit of rock or a crowbar hurled by dynamite inflicts a gunshot-wound, as does a shell-fragment, a pistol-ball, a small birdshot, a rifle-bullet, a flying cap, a piece of wadding, grains of powder, a buckshot, a fragment of metal broken off a shell, grapeshot and canister, or a cannon-ball. Injuries by shell-fragments, portions of a bursted boiler, pieces of masonry or wood, are either lacerated or punctured wounds, and need no special consideration here. In this article we treat of injuries caused by bullets and shot.

The round bullet of the old-time musket being large, moving with comparative slowness, and flattening easily, is very apt to lodge. When it is fired from close range and strikes the tissue at a right angle it produces a "punched-out" entrance-wound. If the velocity is low or the impact is not at a right angle to the tissues, the entrance-wound may "be formed of triangular flaps," the corners of which are inverted.[1] The entrance-wound is surrounded by a bruised area. The track of the bullet is larger than the bullet, is so badly contused and lacerated that much tissue is devitalized, and the shaft of a bone is apt to be splintered if struck. If the ball emerges, the wound of exit is larger than the bullet and forms triangular and everted flaps (Stevenson). Healing by first intention will rarely occur.

The conical or cylindrico-conoidal rifle-bullet has much greater velocity and penetrating power than the round bullet, hence it is more apt to perforate. The track of this bullet is less devitalized than is the track of the round ball and the surface is not so much contused. The wound of entrance is smaller than the bullet and is punched out or in-

[1] *Wounds in War*, by Surg.-Colonel W. F. Stevenson.

verted. The wound of exit is larger than that of entrance, and is often everted. The bones are more seriously comminuted than by the round ball, and the fragments may be driven widely into the tissues (Stevenson); in fact, an explosive effect may occur at close range. Delorme lays it down as a rule that comminution of bone makes the wound of exit larger, and he asserts that a wound of exit larger in diameter than the thumb means that there is comminution of bone.

At the present day the old round ball is very rarely used, the conical projectile having taken its place. For the firearms of civilians, as a rule, the bullets are made of lead, hardened and shaped by compression, or hardened by an admixture with tin. The conical shape of the pistol-ball, the great velocity with which it is propelled and with which it rotates, and its hardness make it unlikely that at near range the bullet will only contuse and not enter the skin. It will almost always enter; it will often lodge and will not unusually perforate; it is rarely deflected, and is not nearly so much flattened by impact as is the softer round ball. A pistol-ball or a spent rifle-ball, however, may fail to enter the tissues, grazing the surface and inflicting a brush-burn, or simply contusing the part. A bullet may enter the tissues, a cavity, or an organ, and lodge there, causing a penetrating wound. It may enter and emerge, causing a perforating wound. The bullet may not enter alone, but may carry with it bits of clothing or other foreign bodies. This complication is much more rare in injury by the conical bullet than by the round ball.

The military surgeon deals with wounds inflicted by small, densely hard, conical projectiles, which are impelled at a great velocity and are carried to long distances. A rifle whose caliber is less than 0.35 inch is known as a small-caliber rifle. The best-known modern rifles are the Lee-Metford, Krag-Jorgensen, Mauser, Männlicher, Lebel, and Schmidt-Rubin. The old Springfield rifle, of a caliber of 0.45 inch, projected a bullet with a velocity of thirteen hundred feet in a second.

The Männlicher rifle, of a caliber of 0.25 to 0.32 inch, sends a bullet with a velocity of over two thousand feet a second. This bullet revolves with great velocity upon its own axis (two thousand times the first second) and is effective at several miles.

The bullet of the modern rifle is conical, has a leaden core, and is hardened by being covered with a mantle or jacket of copper, steel, nickel, or of alloys of copper and nickel, or of copper, nickel, and zinc. The hard jacket is absolutely es-

sential because the speed of the projectile is so great that no soft bullet could succeed in taking the rifling, fragments would be torn from it in the gun, and the grooves of the barrel would soon fill up with metal, the gun becoming useless.

The Lee-Metford bullet is elongated in outline, has a core of lead hardened with antimony, and the envelope is composed of an alloy of nickel and copper.

The older projectile was apt to lodge; was often deflected in the tissues; was flattened out on meeting with resistant structures, such as bone or cartilage, and after flattening became larger and tore and lacerated the soft parts and comminuted the bone.

The new projectile is apt to perforate, is rarely deflected, and is so hard that its shape is generally but little altered

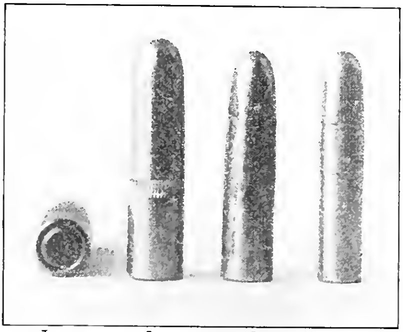


FIG. 64.—1, End view of 2, the Krag-Jorgensen bullet; 3, Mauser bullet; 4, Lee-Metford bullet, used by the U. S. Navy.

on meeting with resistant structures, and hence it was thought that the new bullet would prove more humane than the old projectile, and inflict wounds which would be more easily treated, because the bullets would not lodge and because extensive damage would not be inflicted. This view has proved to a great extent correct. In many instances a modern bullet will make a clear track without laceration or comminution. Senn, Nancrede, and other American surgeons in the Spanish-American War say the modern projectile is humane at a range over fifteen hundred yards, as it generally penetrates cleanly, making a wound which heals often by first intention. Mr. Treves says "the Mauser bullet is a very merciful one." In some instances, however, the small bullet pulpefies structure for a considerable distance around the track of the ball by what is known as the explosive effect. This term does not mean that the bullet has

exploded, but that its sudden impact against tissues has by waves of force caused extensive and distant damage, and often horrible and irreparable injury. Explosive effects are seen most often at close range, when the velocity of the ball and the frequency of its rotation are most marked. A pistol-ball has no explosive action at all, and the old-time bullet possessed it only at very close range. The modern projectile always produces explosive effects up to five hundred yards. Up to thirteen hundred yards it produces them upon the skull and brain. At this distance a single small projectile may entirely destroy the cranium and brain (see Demosthen's studies of the action of the Männlicher rifle). Explosive effects are noted at longer distances upon the liver, spleen, kidney, and lungs, and upon hollow viscera containing fluid.

At a distance of five hundred yards or less a bone will be shattered into many fragments. At a range of fifteen hundred or two thousand yards the bone will be cleanly perforated, usually without comminution. It is often extraordinary how little trouble follows a wound and how quickly healing occurs. This is due to the fact that the bullet is sterile when it reaches the tissue, and that foreign bodies are rarely carried in with it. In some observed cases there have been almost no symptoms after perforation of the lungs, in others after perforation of the abdomen or joints or skull. It is obvious that the humanity of the modern rifle is largely a matter of range. At a range of fifteen hundred yards or more it is a humane weapon.

The wound of entrance is extremely small, and could be overlooked by a careless observer. It is usually circular, but may be triangular. The wound of exit is also small, and may be round or may be a slit. If the injury was inflicted at close range, the wound of exit is large. This projectile theoretically does not flatten, but practically in many instances it does flatten a little, and in others its coat is torn off when it strikes hard bone at a distance of less than eighteen hundred yards. Treves points out that if the bullet smashes a bone and lodges, the shell peels off from the core as a rule, and the bullet may be distorted or even broken into fragments. The bullet may lodge at long range, or if it hits a man after bounding from a stone. In Cuba 10 per cent. of the wounded suffered from lodged bullets. The old-style bullet rarely caused much primary hemorrhage, as the vessels as well as the nerves and tendons were usually pushed aside rather than cut. Hence secondary hemorrhage was common because of contusion of the vessel-walls. The modern bul-

let cuts rather than pushes aside the vessels. Hence primary hemorrhage is profuse if a large vessel is struck, and may prove fatal. The modern bullet rarely lodges and is rarely deflected. Skin is usually split by it. Fascia and muscle are usually much damaged, but in a transverse wound of muscle the fibers may be separated rather than be destroyed (Conner). The effects of the modern bullet have been determined by careful study and experiment; by a study of the wounds in the Chitral Expedition and of wounds inflicted by accident or with homicidal or suicidal intent; by experiments: firing through boxes filled with wet sand; firing into thick oak; firing at cadavers at fixed distances with reduced charges (La Garde); firing at corpses and at live horses with service-charges (Demosthen). Nancrede cautions us to remember that experiments upon the cadaver, employing reduced charges and standing at fixed distances, are uncertain in their provings. "The difference between the velocity of rotation and angle of incidence with reduced charges at fixed distances and service-charges at actual distances are marked. The tension of living muscles and fasciæ, as compared with dead tissues, and the physical change of the semiliquid fat of adipose tissue and medulla to a more solid condition by the loss of animal heat, influence the results."[1]

All theoretical conclusions have been put to the test in the Spanish-American War and the South African War, and preconceived opinions have to a great extent been confirmed. The effect of the bullet at close range was observed in the marines killed at Guantanamo, in persons killed during the Milan riots, and in many instances in South Africa.

It has been found that the modern small-caliber bullet, unless it strikes a vital part or a large bone, lacks "stopping power," and in warfare with savages the bullet must have stopping power, or the wounded man will continue to fight and charge. Civilized men will usually stop when hit, savages often will not; hence, in warfare with barbarous people the ordinary bullet must be modified. In the Dumdum bullet a portion of lead at the apex of the projectile is left uncovered, and the bullet when it strikes spreads out—mushrooms, as it is called—and inflicts an extensive wound which "stops" the most ferocious and fanatical. German surgeons

[1] Nancrede upon "Gunshot Wounds," in Park's *Surgery by American Authors*. For information upon wounds by the modern firearm, see report of Surgeon-General of the United States Army, 1893. Demosthen's study of the wounds inflicted by the Mānnlicher rifle. Prof. Conner, in Dennis's *System of Surgery*, and Forwood, in *The International Text-Book of Surgery*.

denounce such bullets as inhumane, but Stevenson and other English surgeons say that the Dumdum bullet is more humane than the Snider or Martini-Henry. The name Dumdum comes from the ordnance factory, near Calcutta, where bullets of this character were first made.

Wounds by Cannon-balls.—A cannon-ball weighing five or six pounds may be imbedded in tissues. A ball or shell-fragments may tear off a limb or lacerate it extensively. In some cases of injury by spent balls the bone is destroyed and the muscles disorganized while the skin is intact.

Wounds by Small Shot.—Single shot may bruise the surface or may enter the tissues. When many shot enter together they strike as a solid body. Single shot are usually deflected from vessels and nerves, and rarely lodge in bone, but rather flatten on its surface. Numerous shot entering together produce extensive laceration and inflict damage which is often irreparable.

Symptoms of a Gunshot-wound.—Hemorrhage is often considerable, but ceases spontaneously unless a large vessel has been divided. If hemorrhage is profuse, the constitutional symptoms of hemorrhage exist. These symptoms are of great importance in abdominal wounds. A pistol-ball rarely causes severe primary hemorrhage, because it will not often penetrate a large artery. It is apt to push aside a vessel, and secondary hemorrhage is not unusual. Even if a large vessel is wounded and a succession of violent hemorrhages occur, a man may live for several days. Secondary hemorrhage may follow a gunshot-wound because of contusion of vessels or of infection.

Pain is often not noticed at first, especially if the injured individual were greatly preoccupied or excited. There may be a feeling of numbness, but there is usually a dull or stinging pain. If a large nerve is injured, there may be violent pain. Even trivial gunshot-wounds frequently produce profound shock, and yet it may happen that even severe wounds may be accompanied by but slight shock. In most gunshot-wounds of the brain, abdomen, and spinal cord the shock is very great.

General Considerations as to Treatment.—The dangers are shock, hemorrhage, and infection. Bullets are aseptic when they enter a part, and if infection is not inserted in the track of the ball the wound will in most instances heal kindly. "The fate of a wounded man is in the hands of the surgeon who first attends him" (Nussbaum). The danger of a wound depends upon the size and velocity of the bullet, the

part struck, "and the degree of asepsis observed during the first examination and dressing" (Nancrede). The rules of treatment are: bring about reaction, arrest hemorrhage, preserve asepsis, and, in some cases, remove the ball. Always notice if a wound of exit exists. It is a good plan, when endeavoring to determine the extent of injury, to put the parts in the position they were in when the injury was inflicted. We should try to ascertain the size and nature of the weapon, and the range at which it was fired. Examine the clothing to see if any fragments are missing and could have been carried in. Such fragments render sepsis almost inevitable. The surgeon must not feel it his duty to probe in all cases. In many cases it is better not to probe at all. Explore for the ball when sure that it has carried with it foreign bodies; when its presence at the point of lodgement interferes with repair; when it is in or near a vital region (as the brain); and when it is necessary to know the position of the bullet in order to determine the question of amputation or resection. If the wound is large enough, the finger is the best probe.

Fluhrer's aluminum probe is a valuable instrument. It is employed especially in brain-wounds, and is allowed to sink into the track of the ball by the influence of gravity after the part has been placed in a proper position. If a lead bullet is deeply imbedded, it is possible to distinguish the hard projectile from a bone by inserting the asepticized stem of a clay pipe, a bit of pine wood, or Nélaton's porcelain-headed probe. On any one of these appliances lead will make a black mark. No such test can be applied to a modern bullet, for this has a hard metal jacket, and will not make a black mark on a white substance.

Though Nélaton's probe will not show the difference between a hard projectile and bone, it is a valuable instrument to follow the track of a wound. The porcelain head ought to be larger than it is usually made—in fact, it should be nearly the size of the bullet (Senn).

In passing a probe use no more force than in passing a catheter (Senn).

The *induction-balance* of Graham Bell has been employed to determine the situation of a bullet. The bullet may be located by *Girdner's telephonic probe.* In order to construct this instrument, take a telephone receiver, fasten one of the wires to a metal plate and the other one to a metallic probe. Moisten a portion of the patient's body and place the metal plate in contact with it. The surgeon places the receiver to his ear and inserts the probe into the wound. If the probe

strikes metal, a click is heard with distinctness. A bullet may be located by *Lilienthal's probe*. This apparatus consists of a mouth-piece, two insulated copper wires, and a probe. The mouth-piece is composed of two plates, one of copper and one of zinc, which are applied to the sides of the tongue. An insulated wire runs from each plate and into the metal probe. The tip of the probe is composed of two or four pieces of metal, is separated from the shank by a washer of rubber, and is attached to the wires. The operator closes the teeth upon the mouth-piece, and inserts the probe into the wound. If the probe touches the bullet, a distinct and continuous metallic taste is appreciable.

The best means of discovering a bullet is to use the fluoroscope or take a skiagraph. In order to locate it accurately, view it through a series of squares, insert guide-pins, or employ Sweet's apparatus. Bullets are readily seen by the fluoroscope in the superficial soft parts, and are discovered in deeper structures (bone, abdomen, lung, brain, etc.) by taking skiagraphs.

In extracting the ball use very strong forceps (Fig. 64). The old American bullet-forceps is useless for the extraction

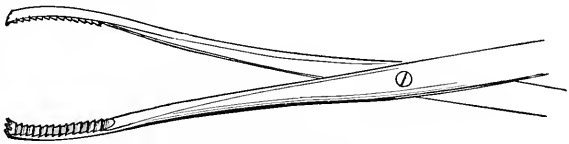


FIG. 65.—Bullet-forceps.

of the hard-jacketed ball, as the points of the instrument will not penetrate and the instrument will not hold.

If hemorrhage is severe in a gunshot-wound, enlarge the wound, find the bleeding vessel, and tie it. Before handling a gunshot-wound asepticize the parts about it and irrigate the wound with hot sterile salt solution. In some situations a wound should be drained with a short tube or a bit of iodoform gauze; in other regions this is unnecessary. The dressing should be antiseptic. Primary union rarely takes place after a wound inflicted by a pistol-ball or an ordinary rifle-ball, because of the inevitable necrosis of damaged tissue in the track of the ball, but in some cases it can be obtained. Primary union is frequent after injury by the small hard-jacketed modern projectile. Healing begins in the depths of the wound and extends toward the wound of entrance, or,

if there be also a wound of exit, toward both. Radical operations may be demanded: laparotomy, trephining, rib-resection, joint-resection, and amputation.

Amputation is sometimes demanded because of great injury to the soft parts (as by a shell-fragment), the splintering of a bone, injury of a joint, damage to the chief vessels or nerves, or the destruction of a considerable part of a limb. Perform a primary amputation if possible, and make the flaps through tissue that will not slough. In civil practice, with careful antisepsis, more questionable tissue can be admitted into a flap than in military practice, where transportation will become necessary and antisepsis may be imperfect or wanting.

Prevention of infection in wounds inflicted in war is of great importance. In warfare at the present day an attempt is made to limit the death-rate from gunshot-wounds by protecting them from infection at an early period after the accident. Esmarch offered a suggestion, which has been adopted in the armies of all civilized countries. Every soldier carries a package which contains antiseptic dressings, and at the first opportunity after the infliction of a wound, if possible on the field, these dressings are applied by the soldier or by a comrade (for even the privates are instructed in the application), or by an ambulance-man. If not applied on the field, they are applied at the first dressing-station by a surgeon or a hospital steward. Senn considers Esmarch's package too cumbrous.[1] He suggests a package containing half an ounce of compressed salicylated cotton. In the center of this cotton is an antiseptic powder (2 gm. of boric acid and $\frac{1}{2}$ gm. of salicylic acid). The cotton is wrapped in a triangular gauze bandage. A safety-pin is placed in the bandage and the entire bundle is wrapped in gutta-percha tissue. Senn says the triangular bandage is sufficient to hold a dressing in place, and it can be assisted by utilizing the gunstrap, safety-belt, or articles of clothing.[2] (For gunshot-wounds of special structures, see Bones, Joints, etc.)

Poisoned wounds are those into which some injurious substance, chemical or bacterial, was introduced. This poison may be microbic and capable of self-multiplication, or it may be chemical, and hence incapable of multiplication. There are three classes of poisons:[3] (1) mixed infection, as septic wounds, dissection-wounds, and malignant edema; (2)

[1] *Jour. Am. Med. Assoc.*, July 13, 1895.
[2] Senn, in *Jour. Am. Med. Assoc.*, July 13, 1895.
[3] *American Text-book of Surgery.*

chemical poison, such as snake-bites and insect-stings; and (3) infection with such diseases as rabies, glanders, etc.

Septic wounds are those which putrefy, suppurate, or slough. Septic wounds should be opened freely to secure drainage, and hopelessly damaged tissue should be curetted or cut away. The wound should be washed with peroxid of hydrogen and then with corrosive sublimate, dusted with iodoform or orthoform, either drained with a tube or packed with iodoform gauze and dressed with hot antiseptic fomentations. The part must be kept at rest and internal treatment should be stimulating and supporting. If lymphangitis arises, the skin over the inflamed vessels and glands is to be painted with iodin and smeared with ichthyol, and quinin, iron, and whiskey are given internally. The temperature is watched for evidence of general infection or intoxication. The patient must be stimulated freely, nourishing food is given at frequent intervals, pain is allayed by anodynes if necessary, and sleep is secured.

Dissection-wounds are simple examples of infected wounds, and they present nothing peculiar except virulence. They affect butchers, cooks, surgeons who cut themselves while operating on infected areas, those who make post-mortems, and those who dissect. A dissection-wound inflicted while working on a body injected with chlorid of zinc possesses but few elements of danger unless the health of the student is much broken down. If a wound is simply poisoned with putrefactive organisms, there is rarely serious trouble. Post-mortems are peculiarly dangerous when the subject has died of some septic process. When a wound is inflicted while dissecting, wash it under a strong stream of water, squeeze, and suck it to make the blood run, lay it open if it be a puncture, paint it with pure carbolic acid, and dress it with iodoform and hot antiseptic fomentations. Trouble, of course, may follow, but often it is only local, and a small abscess forms. It should be treated by hot antiseptic fomentations and early incision. Occasionally lymphangitis arises, adjacent glands inflame, and constitutional symptoms arise. It is rarely that true septicemia or pyemia arises unless the wound was inflicted while making a post-mortem upon a person dead of septicemia or while operating on a septic focus. If glands enlarge, it may be necessary to remove them surgically.

Malignant edema or **gangrenous emphysema** arises most commonly after a puncture. It is due to a specific bacillus which produces great edema. The emphysema

which soon arises is due to mixed infection with putrefactive organisms. Pus does not form, but gangrene occurs. The disease is identical with one form of traumatic spreading gangrene (page 158).

Emphysematous gangrene may also be caused by the bacillus aërogenes capsulatus. The organisms gain access through a wound.

Symptoms.—The symptoms are identical with those of traumatic spreading gangrene with emphysema.

There is a rapidly spreading edema, followed by gaseous distention of the tissues and by gangrenous cellulitis. The zone of edema is at the margin of the emphysema, and the process spreads rapidly. The emphysematous zone crackles when pressed upon. The area of edema is covered with blebs which contain thin, putrid, reddish matter, and the skin becomes mottled. If a wound exists, the discharge will be bloody and foul. If incisions are made, a thin, brown, offensive liquid flows out. High fever rapidly develops, the patient becomes delirious, and often coma arises. In most cases death ensues in from twenty-four to forty-eight hours.

Treatment.—If malignant edema affects a limb, amputate at once, high up. If it affects some other part, make free incisions, employ hot, continuous antiseptic irrigations or the hot antiseptic bath, and stimulate freely.

Stings and Bites of Insects and Reptiles: Stings of Bees and Wasps.—A bee's sting consists of two long lances within a sheath with which a poison-bag is connected. The wound is made first by the sheath, the poison then passes in, and the two lances, moving up and down, deepen the cut. The barbs on the lances make it difficult to rapidly withdraw the sting, which may be broken off and remain in the flesh. Besides bees, hornets, yellow jackets, and other wasps produce painful stings. These stings rarely cause any trouble except pain and swelling. In some unusual cases a bee-sting is fatal; persons have been stung to death by a great number of these insects.

Symptoms.—If general symptoms ensue, they appear rapidly, and consist of great prostration, vomiting, purging, and delirium or unconsciousness. These symptoms may disappear in a short time, or they may end in death from heart-failure. Stings of the mouth may cause edema of the glottis.

Treatment.—To treat a bee-sting, extract the sting if it be broken off, and apply locally ichthyol, a solution of wash-

ing-soda, ammonia-water, tincture of arnica, iodin, or lead-water and laudanum. If constitutional symptoms appear, stimulate.

Other Insect-bites and Stings.—The mandibles of a poisonous spider are terminated by a movable hook which has an opening for the emission of poison. The bite of large spiders is productive of inflammation, swelling, weakness, and even death. The bite of the poisonous spider of New Zealand produces a large white swelling and great prostration; death may ensue, or the victim may remain in a depressed, enfeebled state for weeks or even for months. The tarantula is a much-dreaded spider. A scorpion has in its tail a sting. The sting of a scorpion produces great prostration, delirium, vomiting, diaphoresis, vertigo, headache, local swelling, and burning pain, followed often by suppuration, or even by gangrene and fever. Centipedes must be of large size to be formidable to man, and the symptoms arising from their stings are usually only local.

Treatment.—Tie a fillet above the bitten point; make a crucial incision, favor bleeding, and paint the wound with pure carbolic acid or some caustic or antiseptic (if in the wilds, burn with fire or gunpowder); dress antiseptically if possible, and stimulate as constitutional symptoms appear. Slowly loosen the ligature after symptoms disappear. Chloroform stupes and ipecac poultices are recommended; also puncture with a needle and rubbing in a mixture of 3 parts of alcohol and 1 part of camphor (Bauerjie).

Snake-bites.—The poisonous snakes of America comprise the copperheads, water-moccasins, rattlesnakes, and vipers. There is also a poisonous lizard. The symptoms of snake-bite are similar whether it is the bite of an Indian cobra or of an American rattler, and they depend upon the dose of poison introduced. Poison injected into a vein may prove almost instantly fatal. The poison is not absorbed by the sound mucous membranes. It is discharged through the hollow fangs of the reptile, having been forced out by contractions of the muscles of the poison-bag. In most varieties of snakes the teeth lie along the back of the mouth and are only erected when the reptile strikes. The poison contains proteid constituents, globulins, and peptones (Mitchell and Reichert), and probably toxic animal alkaloids (Brieger). S. Weir Mitchell has shown that rattlesnake venom exerts a paralyzing action upon the walls of the smaller blood-vessels, converts the blood into a non-coagulable fluid, causes the white blood-cells and the fluid elements

of blood to extravasate into the tissues, and disintegrates the red corpuscles.

Symptoms.—The symptoms are—pain, soon becoming intense; mottled swelling of the bitten part, which swelling may be enormous, and which is due to edema and extravasation of blood, and assumes a purpuric discoloration. There may be complete consciousness, or there may be lethargy, stupor, or coma. Some cases present spasms. The general symptoms are those of profound shock, which may present delirium (delirious shock). Death may arise from paralysis of the heart or paralysis of respiration, and may occur in about five hours, but as a rule it is postponed for a number of hours. If death is deferred many hours, profound sepsis comes upon the scene, with glandular enlargement, suppuration, and sometimes gangrene.

Treatment.—Cases of snake-bite must, as a rule, be treated without proper appliances. The elder Gross was accustomed to relate in his lectures how he had seen an army officer blow off his finger with a pistol the moment it was struck, and thus escape poisoning. In general, the rules are to twist several fillets at different levels above the bite, to excise the bitten area, to suck or cup it if possible, and to cauterize it with a pure acid or by heat. An expedient among hunters is to cauterize by pouring gunpowder on the excised area and applying a spark, or by laying a hot ember on the wound. When a hot iron is available, use it. The fillets are not to be removed suddenly, and they had best be kept on for some time. Remove the highest constricting band first; if no symptoms come on after a time, remove the next, and so on; if symptoms appear, reapply the fillet. The constitutional treatment is expressed in one word: stimulate. Our only hope is in large doses of alcohol, and, if they can be obtained, ammonia, ether, strychnin, or digitalis hypodermatically administered. Large doses of strychnin hypodermatically are used by many surgeons in India. Morphin may be required for pain. There is no specific for snake-poison. Hypodermatic injections of a 1 per cent. solution of the permanganate of potassium in the area adjacent to the bite are commended by some. The local use of chlorid of lime has recently been recommended. Halford of Australia praises the intravenous injection of ammonia (10♏ of strong ammonia in 20♏ of water). If a man is bitten by a large and deadly snake, the surgeon, if one is at hand, should at once amputate well above the bite.[1] Attempts are being made to

[1] Charters James Symonds, in *Heath's Dictionary of Practical Surgery.*

obtain a curative serum. Animals can be rendered immune by giving them at first small doses of the poison and gradually increasing the amount administered. It is asserted that the serum of immune animals will cure a person bitten by a venomous snake. Cures have been reported after the use of Calmette's antivenene serum. The dose is 20 c.c. hypodermatically, repeated if necessary in three or four hours. Alexander[1] treated a case successfully by making an incision into the bitten area, pouring into the wound rattlesnake bile, and giving carbonate of ammonium internally. The poisonous lizard (Gila monster) can kill small animals, but it is not believed that its bite would prove fatal to man.

Anthrax (malignant pustule, charbon, wool-sorters' disease, Milzbrand, or splenic fever) is a term used by some as synonymous with ordinary carbuncle, but it is not here so employed. Anthrax, as met with in man, is a disease contracted in some manner from an animal with splenic fever. It may be contracted by working around diseased animals, by handling or tanning their hides, by sorting their hair or wool; it may be conveyed by eating infected meat or by drinking infected milk. Flies may carry the poison. Inhalation of poisoned dust may infect the lungs. Catgut ligatures may be contaminated and carry the poison. Many attempts, not altogether satisfactory, have been made to render animals immune (Pasteur, Woolbridge, Hankin). Certain organisms are antagonistic to anthrax (the streptococcus of erysipelas, the pneumococcus, the micrococcus prodigiosus, and the bacillus pyocyaneus).

Forms of Anthrax.—There are two forms of the disease —external and internal. Internal anthrax may be intestinal from eating diseased meat or pulmonary from inhalation of poisoned dust. External anthrax may be anthrax carbuncle or anthrax edema. The *external* form appears in from three to six days after inoculation, and presents a papule with a red base; the papule becomes a vesicle which contains bloody serum; the vesicle bursts and dries, the base of it swells and enlarges, other vesicles appear in circles around it, and there is developed an "anthrax carbuncle," which shows a black or purple elevation with a central depression surrounded by one or more rings of vesicles. Pain is trivial. Lymphatic enlargements occur. Within forty-eight hours after the pustule begins microörganisms appear in the blood. In loose connective tissue the lesion may be anthrax edema, a spreading livid edema followed by blebs and even by gangrene. The

[1] *Medical Record*, Sept. 5, 1896.

constitutional symptoms may rapidly follow the local lesion, but may be deferred for a week or more. The patient feels depressed, has obscure aches and pains, and is feverish, but usually keeps about for a short period. After a time he is apt to develop rigors, high irregular fevers, sweats, acute fugitive pains, diarrhea, delirium, typhoid exhaustion, dyspnea, cough, and cyanosis. The carbuncle of anthrax is distinguished from ordinary carbuncle by the central depression, the adherent eschar, the absence of pain, tenderness, and the absence of suppuration of the first, as contrasted with the elevated center, the multiple foci of suppuration and sloughing, and the acute pain of the second. Anthrax edema differs from cellulitis in the absence of all tendency to form pus, and from malignant edema by the greater tendency of the latter to result in gangrene. If anthrax has a visible lesion and the constitutional symptoms are slight or absent, the chance of cure is good.

Treatment.—If a person is wounded by an object suspected of carrying the infection, cauterize the wound with the hot iron. A sufferer from anthrax must be isolated in a well-ventilated room. All dressings are to be burnt, all discharges asepticized, and after the removal of the patient the bed-clothes are burnt and the room disinfected. A malignant pustule should be entirely excised, and the wound mopped out with pure carbolic acid or burnt with the hot iron, and afterward dressed with wet bichloride-of-mercury gauze which is covered with an ice-bag. Excision should be practised even when glands are enlarged, but it will prove ineffectual if organisms are present in the blood. When excision cannot be performed make crucial incisions through the lesion, mop the wounds with pure carbolic acid, and inject about and in the pustule carbolic acid (1 : 10) every six hours until the disease abates or toxic symptoms appear. The adherent eschar is subsequently removed by hot antiseptic fomentations. Davaine advised the following plan: Inject the pustule and the tissues about it at many points every eight or ten hours with 1 part of tincture of iodin diluted with 2 parts of water or with a 10 per cent. solution of carbolic acid, or with a $\frac{1}{10}$ per cent. solution of corrosive sublimate. Dress with wet antiseptic gauze and apply an ice-bag. The skin over inflamed lymphatic vessels and glands should be painted with iodin and smeared with ichthyol. Constitutional treatment must be sustaining and stimulating. Maffucci gives carbolic acid internally, and also uses it externally. Davies-Colley uses ipecac locally and gives large doses by the

mouth. Pulmonary anthrax and intestinal anthrax are always fatal. The treatment is symptomatic.

Hydrophobia, Rabies, or Lyssa.—Hydrophobia is a spasmodic and paralytic disease due to infection through a wound with the virus from a rabid animal. The animal may be a dog, a cat, a wolf, a fox, or a horse. Roux estimates that about 14 per cent. of the people bitten by mad animals develop the disease. If the bite is on an exposed part, it is far more apt to cause rabies than if the teeth pass through clothing. The saliva is the usual vehicle of contagion, but other fluids and tissues contain the virus, especially the brain and cord. Hydrophobia has been known for centuries. At the present day some ardent antivivisectionists dispute its existence. The fact that it can occur in an infant after it has been bitten by a rabid animal proves that the disease is not due to the imagination. Hydrophobia is almost invariably fatal.

Symptoms.—The period of incubation of hydrophobia is from a few weeks to several months, and it has been alleged that it may even be two years. The initial symptoms are mental depression, anxiety, headache, malaise, and often pain or even congestion in the cicatrix, which symptoms are quickly followed by a general hyperesthesia, pharyngeal spasms, dyspnea from laryngeal spasms, and constant attempts to expectorate thick mucus which forms because of congestion of the air-passages. Attempts at swallowing, as well as lights and noises, tend to bring on spasms, hence the fear of liquids (there is spasm from attempts at swallowing, and even in some cases from thinking of the act). The entire body may be thrown into clonic spasms, but there is no tonic spasm. The mind is usually clear, although during the periods of excitement there may be maniacal furor with hallucinations which pass away in the stage of relaxation. The temperature is moderately elevated (101° to 103° F. or higher). The spasmodic stage lasts from one to three days, and the patient may die during this stage from exhaustion or from asphyxia. If he lives through this period, the convulsions gradually cease, the power of swallowing returns, and the patient succumbs to exhaustion in less than twenty-four hours, or he develops ascending paralysis which soon causes cardiac and respiratory failure.

In hydrophobia death is practically inevitable. Almost all cases in which it is alleged that recovery ensued were not true hydrophobia, but hysteria. Wood says that in hysteria, especially among boys, "beast-mimicry" is common, the

sufferer snarling like a dog, and in the form known as "spurious hydrophobia," in which there may or may not be convulsion, there are a dread of water, emotional excitement, snarling, and attempts to bite the bystanders (in genuine hydrophobia no attempts are made to bite, and no sounds are uttered like those made by a dog).

Lyssa is separated from lockjaw by the spasms of the larynx and the absence of tonic spasms in the former, as contrasted with the fixation of the jaws and the tonic spasms with clonic exacerbations of lockjaw.

Treatment.—When a person is bitten by a supposed rabid animal and is seen soon after the injury, constriction should be applied if possible above the wound, the wounded area should be excised, cauterized with a hot iron or the Paquelin cautery, and dressed antiseptically. If the patient is not seen for a number of hours or a day or two after the injury, cauterization is useless; and it is not only useless, but it may delude the patient and his friends with a feeling of security. In any case, send the patient at once to a Pasteur institute. If the animal which inflicted the injury was not hydrophobic, no harm will result from inoculations; if it was hydrophobic, preventive treatment may save the patient. The method known as the preventive treatment was devised by Pasteur, who discovered the following remarkable facts: If the virus of a rabid dog (street rabies) be placed beneath the dura of another dog, it *always* causes hydrophobia in from sixteen to twenty days, and invariably causes death. If the virus is passed through a series of rabbits it gets stronger (laboratory virus), and if inserted beneath the dura of a dog it causes the disease in from five to six days, and kills in four or five days. The virus can be attenuated by passing it through a series of monkeys or by keeping it for a definite time. To obtain attenuated preparations in a convenient form Pasteur made emulsions from the spinal cords of hydrophobic rabbits, the animals having been dead two or three weeks. He found that the emulsion obtained from the rabbit longest dead is the weakest. He injected a dog with emulsions of progressively increasing strength and made it immune to hydrophobia. The patient is injected with an emulsion made from the dried spinal cords of hydrophobic rabbits. In this emulsion the virus is attenuated, and day by day the strength of the injected virus is increased. These emulsions cause the body-cells to form antitoxin, and either the virus of street rabies does not develop at all or by the time it begins to develop a quantity of antitoxin is present to an-

tagonize it. In the New York Pasteur Institute patients remain under treatment for fifteen days, two inoculations being given daily. In cases in which treatment was begun late, or in which the head or face was bitten, from four to six inoculations are given each day. The report of the Parisian Pasteur Institute shows that since its foundation there has been a mortality of 0.5 per cent. The lowest estimated number of those attacked by hydrophobia before this method was used was 5 per cent. of those bitten, and all attacked died; hence, the Pasteur treatment shows one-twenty-fifth of the mortality which attends other preventive methods. The value of this plan seems definitely established. The general public believe that the dog which did the biting should be killed. The dog should, if possible, be locked up and watched rather than killed. It may be proved in this way that the dog did not have hydrophobia. If it were necessary to kill the dog or if the dog was killed at once or soon after, the physicians of the New York Pasteur Institute advise that the dog's head be cut from the body with an aseptic knife and a piece of the medulla oblongata be abstracted. The bit of medulla is placed in a mixture of equal parts of glycerin and water which was previously sterilized by boiling. The bottle should be sealed and sent to the Institute, in order that inoculations may be made upon animals to prove the existence or absence of hydrophobia. Murri, of Bologna, cured a case of hydrophobia by injecting emulsions of cords of rabbits dead six, five, four, and three days respectively. It would be proper to try this remedy if hydrophobia develops. In the paroxysm of hydrophobia the treatment in the past was purely palliative. If we employ only palliative methods, keep the patient in a dark, quiet room, relieve thirst by enemata, saturate him with morphin, empty the bowels by enemata, attend to the bladder, and during the paroxysms anesthetize.

Glanders, Farcy, or Equinia.—Glanders is an infectious eruptive fever occurring in horses and communicable to man. If the nodules occur in a horse's nares, the disease is called "glanders;" if beneath the skin, it is termed "farcy." This disease is due to a bacillus, and is communicated to man through an abraded surface or a mucous membrane (Osler). The characteristic lesions are infective granulomata, which in the nose form ulcers and under the skin develop into abscesses.

Acute and Chronic Glanders.—In acute glanders there is septic inflammation at the point of inoculation; nodules form in the nose, and ulcerate; there is profuse nasal discharge;

the glands of the neck enlarge; there are fever and an eruption like small-pox on the face and about the joints (Osler), and severe muscular pain. Acute glanders is always fatal. Chronic glanders lasts for months, is rarely diagnosticated, being mistaken for catarrh, and is often recovered from. The diagnosis can be made by injecting a guinea-pig with the nasal mucus.

Acute and Chronic Farcy.—Acute farcy arises at the site of a skin-inoculation; it begins as an intense inflammation, from which run out inflamed lymphatics that present nodules or "farcy-buds." Abscesses form. There are joint-pain and the constitutional symptoms of sepsis, but no involvement of the nares. Chronic farcy may last for months. In it nodules occur upon the extremities, which nodules break down into abscesses and eventuate in ulcers resembling those of tuberculosis.

Treatment.—In treating this disease the point of infection is at once to be incised and cauterized, dusted with iodoform, and dressed antiseptically. The skin over enlarged glands and swollen lymphatics is to be painted with iodin and smeared with ichthyol. Bandages are applied to edematous extremities. Ulcers are curetted, touched with pure carbolic acid, dusted with iodoform, and dressed antiseptically. The nostrils should be sprayed at frequent intervals with peroxid of hydrogen, and frequently syringed with a solution of sulphurous acid. The mouth must be rinsed repeatedly with solutions of chlorate of potassium. Abscesses are to be opened, mopped with pure carbolic acid, and dressed antiseptically. Stimulants and nourishing diet are imperatively demanded. Morphin is necessary for the muscular pain, restlessness, and insomnia. Digitalis is given to stimulate the circulation and kidney secretion. Sulphur iodid, arsenite of strychnin, and bichlorate of potassium have been used. Diseased horses ought at once to be killed and their stalls ought to be torn to pieces, purified, and entirely rebuilt. A man with chronic glanders should be removed to the seaside. The nasal passages should be kept clean and the ulcers must be cauterized and dressed with iodoform gauze. Nutritious foods, tonics, and stimulants are necessary.

Actinomycosis is an infectious disorder characterized by chronic inflammation, and is due to the presence in the tissues of the *actinomyces*, or ray-fungus. This disease occurs in cattle (lumpy jaw) and in pigs, and can be transmitted to man, usually by the food. At the point of inoculation (which is generally about the mouth) arises an infective granuloma,

around which inflammation of connective tissue occurs, suppuration eventually taking place. Inoculation in the mouth is by way of an abrasion of mucous membrane or through a carious tooth. Chewing straw which contains the fungi is the most common method of infection. The ray-fungi may pass into the lungs, causing pulmonary actinomycosis ; into the intestines, causing intestinal actinomycosis ; into the skin, the bones, the subcutaneous tissues, the heart, the brain, the liver, etc. Cases of human actinomycosis until very recently were looked upon as sarcomata.

Cutaneous actinomycosis may be secondary to a visceral area of disease, may be a purely local condition, or may be associated with some adjacent area of bone-infection. The gummatous form of the disease resembles a gummatous syphilitic area, and in it many small purulent pockets open by fistulæ (Monestié).

In the anthracoid form there are no distinct purulent collections, but many fistulæ discharge pus at various points (Monestié).

An area of cutaneous actinomycosis is characterized by the existence of violet, blue, gray, or black maculæ, varying in size from that of a pin's head to that of a bean, the center of each macule being white and containing a minute quantity of pus (Derville).

The pus of actinomycosis contains many sulphur-yellow bodies, visible to the naked eye and composed of fungi. These bodies feel gritty when rubbed between the fingers because of the presence of lime salts.

In actinomycosis of bone the bone enlarges and becomes painful, the parts adjacent swell from infiltration and soften, pus forms and reaches the surface through fistulæ, and the skin often becomes involved secondarily.

In actinomycosis the adjacent lymphatic glands are not involved. The diagnosis must be made from syphilis, sarcoma, and tuberculosis. The microscopic examination of the pus makes the diagnosis.

Treatment.—Free excision if possible ; otherwise incision, cauterization with pure carbolic acid, and packing with iodoform gauze. Give internally large doses of iodid of potassium. This drug alone has cured many cases.

Wounds of Mucous Membranes.—If the surgeon intends to inflict a wound upon a mucous surface, he should see to it that the patient's general condition is good. Thorough asepsis is impossible, and a good result depends largely upon the vital resistance of the tissues. Before operating

irrigate the part frequently with boric acid, peroxid of hydrogen, or normal salt solution. When ready to sew up the wound be sure that all irritant fluids are removed (saliva in the mouth, etc.). Cleanse the wound with hot normal salt solution. The stitches must include submucous tissue as well as the mucous membrane, and consist of silver wire, silk, or silkworm-gut. After sewing up a wound in the mouth, wash at frequent intervals with salt solution, and follow each washing with the insufflation of iodoform.

In accidental wounds irrigate with salt solution, dust with iodoform, and close as directed above. Corrosive sublimate is so irritant that it does harm when applied to a mucous membrane.

XVI. SYPHILIS.

Definition.—Syphilis is a chronic contagious, and sometimes hereditary, constitutional disease. Its first lesion is an infecting area or chancre, which is followed by lymphatic enlargements, eruptions upon the skin and mucous membranes, affections of the appendages of the skin (hair and nails), "chronic inflammation and infiltration of the cellulovascular tissue, bones, and periosteum" (White), and, later, often by gummata. This disease is probably due to a microbe, but Lustgarten's bacillus has not been proved to be the cause. One fact against its being the cause is its presence in the non-contagious late gummata. White quotes Fenger in his assumption that syphilitic fever is due to absorption of toxins; that the eruptions of skin and mucous membranes in the secondary stage arise from local deposit and multiplication of the virus; that many secondary symptoms result from nutritive derangement caused by tissue-products passing into the circulation; that the virus exists in the body after the cessation of secondary symptoms; and that it may die out or may awaken into activity, producing "reminders."

During the primary and secondary stages fresh poison cannot infect, and this is true for a time after the disappearance of secondary symptoms. Immunity in the primary stage is due to products absorbed from the infected area. Colles's immunity is that acquired by mothers who have borne syphilitic children, but who themselves show no sign of the disease. Profeta's immunity is the immunity against infection possessed by many healthy children born of syphilitic parents. Tertiary syphilitic lesions are not due to the poison of syphilis, but to tissue-products resulting from the action

of that poison, or to nutritive failure as a consequence of the disease. Tertiary syphilis is not transmissible, but it secures immunity.

Transmission of Syphilis.—This disease can be transmitted—(1) by contact with the tissue-elements or virus—*acquired* syphilis; and (2) by hereditary transmission—*hereditary* syphilis. The poison cannot enter through an intact epidermis or epithelial layer, and abrasion or solution of continuity is requisite for infection. Syphilis is usually, but not always, a venereal disease. It may be caught by infection of the genitals during coition, by infection of the tongue or lips in kissing, by smoking poisoned pipes, by drinking out of infected vessels, or by beastly practices. The initial lesion of syphilis may be found on the finger, penis, eyelid, lip, tongue, cheek, palate, anus, nipple, etc. A person may be a host for syphilis, carry it, give it to another, and yet escape it himself (a surgeon may carry it under his nails, and a woman may have it lodged in her vagina). Syphilis can be transmitted by vaccination with human lymph which contains the pus of a syphilitic eruption or the blood of a syphilitic person. Vaccine lymph, even after passage through a person with pox, will not convey syphilis if it is free from blood and the pus of specific lesions; it is not the lymph that poisons, but some other substance which the lymph may carry.

Syphilitic Stages.—Syphilis was divided by Ricord into three stages: (1) the *primary* stage—chancre and indolent bubo; (2) the *secondary* stage—disease of the upper layer of the skin and mucous membranes; and (3) the *tertiary* stage—affections of connective tissues, bones, fibrous and serous membranes, and parenchymatous organs. This division, which is useful clinically, is still largely employed, but it is not so sharp and distinct as was believed by Ricord; it is only artificial. For instance, ozena may develop during a secondary eruption, and bone disease may appear early in the case.

Syphilitic Periods.—White divides the pox into the following periods: (1) period of *primary incubation*—the time between exposure and the appearance of the chancre: from ten to ninety days, the average being three weeks; (2) period of *primary symptoms*—chancre and bubo of adjacent lymph-glands; (3) period of *secondary incubation*—the time between the appearance of the chancre and the advent of secondary symptoms: about six weeks as a rule; (4) period of *secondary symptoms*—lasting from one to three years; (5)

intermediate period—there may be no symptoms or there may be light symptoms which are less symmetrical and more general than those of the secondary period: it lasts from two to four years, and ends in recovery or tertiary syphilis; and (6) period of *tertiary symptoms*—indefinite in duration. The fifth and sixth periods may never occur, the disease having been cured.

Primary Syphilis.—The primary stage comprises the chancre or infecting sore and bubo. A chancre or initial lesion is an infective granuloma resulting from the poison of syphilis. A chancre may be derived from the discharges of another chancre, from the secretion of mucous patches and moist papules, from syphilitic blood, or from the pus or secretion of any secondary lesion. Tertiary lesions cannot cause chancre. It appears at the point of inoculation, and is the first lesion of the disease. During the three weeks or more requisite to develop a chancre the poison is continuously entering the system, and when the chancre develops the system already contains a large amount of poison. A chancre is not a local lesion from which syphilis springs, but is a local manifestation of an existing constitutional disease, hence excision is entirely useless. If we take the discharge of a chancre and insert it at some indifferent point, into the person from whom we took it, a new indurated chancre will not be formed, because the individual already has syphilis, but auto-inoculation with the discharge of an *irritated* chancre can cause a *non-indurated* sore. If we take the discharge of a chancre and insert it into a healthy person, an indurated chancre follows. Hence we say that primary syphilis is not auto-inoculable, but is hetero-inoculable. A soft sore can be produced in the lower animals by inoculation with the virus of a chancre, but a hard sore cannot. Some observers, notably Kaposi, of Vienna, advocate the unity theory. This theory maintains that both hard and soft sores are due to the same virus, the infective power of the soft chancre simply being less than that of the hard sore, the possibility of constitutional infection depending, not upon differences in the poison, but rather upon differences in the soil and in the local processes. The unicists advocate excision of chancres, soft or hard, to prevent, if possible, constitutional involvement. Most syphilographers believe in the duality theory, which we have previously set forth. This theory took origin from the classical investigations of Bassereau and Rollet. The duality theory maintains that the soft sore is caused by

a poison different from that which originates the hard sore, and that a true soft sore never infects the system.[1]

Initial Lesions.—An initial lesion, hard chancre, or infecting sore never appears until at least ten days after exposure; it may not appear for many weeks, but it usually arises in about twenty-five days. There are three chief forms of initial lesion: (1) a purple patch exposed by peeling epidermis, without induration and ulceration—a rare form; (2) an indurated area under the epidermis, without ulceration—a very common form; and (3) a round, indurated, cartilaginous area with an elevated edge, which ulcerates, exposing a velvety surface looking like raw ham; it bleeds easily, rarely suppurates, does not spread, and the discharge is thin and watery. This is the "Hunterian chancre," which is rarer than the second variety, but commoner than the first, and which ulcerates because of dirt, caustic applications, or friction.

A chancre is rarely multiple; but if it is so, all the sores appear together as a result of the primary inoculation; they do not follow one another because of auto-infection. A hard sore does not suppurate unless irritated by caustics, friction, or dirt, or unless there be mixed infection with chancroid; its nature is not to suppurate. The hardness may affect only the base and margins of an ulcer or it may affect considerable areas, but it has well-defined margins and feels like cartilage encapsuled, so that it can be picked up between the fingers. This hardness or sclerosis is due to gradual inflammatory exudation into "the tissues at the base of the ulcer and to growth of the nodule" (von Zeissl). It feels distinct from the surrounding tissues, like a foreign body lying in the part. A chancre untreated may last many months. The induration usually disappears soon after the appearance of secondary symptoms. A copper-colored spot remains, and does not disappear until the disease is cured. Induration may again appear before the outbreak of some distant lesion.

Mixed Infection of Chancre and Chancroid.—Von Zeissl says: "If syphilitic contagion is mixed with pus, a chancre begins as a circumscribed area of hyperemia and swelling, which undergoes ulceration, and does not develop hardness for a period of from ten days to several weeks, and may develop a nodule after the first ulcer has entirely healed." This condition is seen when mixed infection occurs, the chancroid poison being quick, and the syphilitic poison being slow, to act. If chancroid poison is deposited some time

[1] For a full discussion of these points see the writings of Fournier, Alfred Cooper, and von Zeissl, and especially the great work of Taylor.

after the syphilitic poison has been absorbed, the induration may appear in a few days after the chancroid begins. A soft chancre may appear upon an existing syphilitic nodule and may eat out the induration.

Diagnosis of Chancre.—It is necessary to distinguish a chancre from a chancroid and from ulcerated herpes. A chancroid appears in from two to five days after contagion (always less than ten days); it may be multiple from the start, but, even if beginning as one sore, other sores appear by auto-inoculation; it begins as a pustule, which bursts and exposes an ulcer; the ulcer is circular, has thin, sharp-cut, or undermined edges, a sloughy, non-granulating base, and gives origin to a thin, purulent, offensive discharge which is both auto- and hetero-inoculable. These soft sores have no true sclerotic area, do not bleed, produce no constitutional symptoms, and are apt to be followed by acute inflammatory buboes which tend to suppurate. A chancroid causes pain, and the original ulcer enlarges greatly. A chancre appears in about twenty-five days after inoculation (never before ten days); it is generally single, but if multiple sores exist, they all appear together, for their discharge is not auto-inoculable if the sore is not irritated; an auto-inoculation of the products of an irritated chancre can at most produce only a soft purulent ulcer. A chancre begins as an excoriation or as a nodule; if an ulcer forms, its floor is covered with granulations and it is red and smooth; the discharge is thin and scanty and not offensive; the edges are thick and sloping; it is surrounded by an area of induration, and bleeds when touched, there appear about the same time with it indolent multiple enlargements of the adjacent glands, which rarely suppurate, and it is followed by secondary symptoms. A chancre causes little pain, and after it has existed for a few days rarely shows any tendency to spread. A urethral chancre appears at the usual period of incubation; it is situated near the meatus, one lip of which is usually indurated; the discharge is slight, often bloody, and never purulent; indurated multiple buboes arise; the sore can be seen, and constitutional symptoms follow.

Herpetic ulceration has no period of incubation; it may follow fever, but usually arises from friction or irritation due to dirt or acrid discharges. It appears as a group of vesicles, all of which may dry up, or some may dry up and others ulcerate, or they may run together and ulcerate. The edges of a herpetic ulcer are in "segments of small circles" (White); the ulcer is superficial, has but little discharge, and does not have much tendency to spread; it has no induration; it is

16

painful; it is not accompanied by bubo unless suppuration is extensive. Herpes is not followed by constitutional involvement.

A chancre may be mistaken for cancer of the tongue. "A chancre of this region is brownish-red, a cancer being bright red. A chancre is soft in the center; a cancer presents uniformity of induration. A chancre gives origin to a thin, purulent discharge, free from blood; a cancer furnishes a non-purulent, bloody discharge. A chancre is followed by indolent lymphatic enlargements under the jaw; a cancer is followed by painful enlargements." A cancer is slower in evolution, is not followed by constitutional symptoms, and the lymphatic enlargements are much later in appearing than in chancre.

Phagedena.—A chancre or a chancroid may be attacked by phagedena, a destructive form of ulceration which was once common, but at present is rare. The ulceration often spreads on all sides and also deeply into the tissues. In some cases it spreads in only one direction (serpiginous ulceration), in some cases sloughing occurs. Phagedena occurs only in the debilitated (anemic, drunkards, strumous subjects, sufferers from diabetes, Bright's disease, etc.; salivation can cause it). The phagedenic ulcer is irregular, with congested and edematous edges, and a foul, sloughy floor.

Chancre Redux.—Some observers believe that reinfection with syphilis is not very unusual (Hutchinson). Most authorities maintain that it is very rare (Taylor). The latter school maintains that the region once occupied by a chancre may, after many years, become indurated anew. Fournier pointed out this fact thirty years ago. Such a reinduration is called chancre redux, or relapsing chancre.

If syphilitic manifestations follow such an induration, we must conclude that reinfection has truly occurred. If they do not follow, and this is the rule, the lesion is not really a chancre, but is probably a gumma in an early stage of development. Mauriac pointed out this last fact.[1]

Syphilitic Bubo.—In syphilitic bubo anatomically related lymphatic glands enlarge about the same time as induration of the initial lesion begins. In the very beginning these glands may be a little painful, but the pain is slight and of temporary duration. These enlargements are called "indolent buboes;" they may be as small as peas or as large as walnuts, are freely movable, and very rarely suppurate. The

[1] Mracek, in *Wien. klin. Rundschau*, 1896. H. G. Antony, in *Chicago Medical Recorder*, April, 1899.

lesion of the glands is hyperplasia of all the gland-elements and of their capsules, due to absorption of the virus. If the patient is tubercular, the bubo is apt to become enormous, lobulated, and persistent. If the chancre appears on the penis, the superficial inguinal and femoral glands enlarge, usually on the same side of the body as the sore. If the sore is on the frenum, both groins are involved. If a chancre appears on the lip or tongue, the bubo is beneath the jaw. These buboes may remain for many months; they do not suppurate unless the sore suppurates or unless the patient is of the tubercular type; and they finally disappear by absorption or fatty degeneration. About six weeks after buboes have formed in the glands related to the lesion all the lymphatics of the body enlarge. General lymphatic involvement arises about the same time as the secondary eruption. The enlargement of the post-cervical and epitrochlear glands is diagnostically important. Glandular enlargements persist until after the eruptions have disappeared.

Glandular enlargement always occurs in syphilis, but the bubo exists in only one-third of the chancroid cases. The bubo of syphilis is multiple, consisting of a chain of movable glands (the glandulæ Pleiades of Ricord); the bubo of chancroid is one inflamed and immovable mass. The bubo of syphilis is indurated, painless, small, and slow in growth; the bubo of chancroid shows inflammatory hardness, is painful, large, and rapid in growth; the first rarely suppurates, the second often does. The skin over a syphilitic bubo is normal; that over a chancroidal bubo is red and adherent. A syphilitic bubo is not cured by local treatment, but is cured by the internal use of mercury and is followed by secondary symptoms. A chancroidal bubo requires local treatment, is not cured by mercury, and is not followed by secondaries. Herpes, balanitis, and gonorrhea rarely cause bubo, but when they do the bubo in each case is similar to that caused by chancroid. A positive diagnosis of syphilis can be made when an indurated sore is followed by multiple indolent buboes in the groin and by enlargement of distant glands.

General Syphilis.—As the general lymphatic enlargement becomes manifest there is apt to appear a group of symptoms known as "syphilitic fever." The patient usually thinks he has a severe cold, is feverish and restless; complains of sleeplessness and anorexia; his face is pale; he has intermitting rheumatoid pains in the joints and muscles, especially of the shoulders, arms, chest, and back, which pains change their location constantly and prevent sleep;

nightsweats occur, and the pulse is quite frequent. The fever usually reaches its height in forty-eight hours, and falls as the eruption develops. Syphilitic fever does not occur in every case. It may reappear during the progress of the disease.

Secondary Syphilis.—The phenomena of secondary syphilis are due to poisoned blood. Fenger states that the poison is present in the blood during outbreaks, but not during the quiescent periods between outbreaks. Secondary syphilis is characterized by plastic inflammation, by the formation of fibrous tissue, and by thickening of tissue. Superficial ulcerations may occur. Structural overgrowths appear (for instance, warts).

Syphilitic Skin Diseases.—*Syphilodermata* (syphilides) are due to circumscribed inflammation, and may be dry or purulent. There is no one eruption characteristic of syphilis. This disease may counterfeit any skin disease, but it is an imitation which is not perfect and is never a counterpart. Syphilitic eruptions are often circumscribed; they terminate suddenly at their edges, and do not gradually shade into the sound skin. In color they are apt to be brownish-red, like tarnished copper; especially is this the case in late syphilides. Hutchinson cautions us to remember that an ordinary non-specific eruption may be copper-colored, especially in people with dark complexion and when it occurs on the legs. Eruptions are apt to leave a brownish stain. Early syphilitic eruptions are symmetrical. Syphilitic eruptions have an affection for particular regions, such as the forehead, the abdomen and chest, the neck and scalp, about the lips and the alæ of the nose, the navel, anus, groins, between the toes, and upon the palms and soles. Early secondary eruptions rarely appear on the face or hands. Specific eruptions are polymorphous, various forms of eruption being often present at the same time, so that roseola is seen here, papules there, etc. These syphilides do not cause as much itching as do non-specific eruptions, except when they occur upon the scalp, about the anus, or between the toes. The late secondary eruptions tend to an arrangement in curved lines.

Forms of Eruption.—The chief forms of eruption are (1) erythema, (2) papular syphilides, (3) pustular syphilides, and (4) tubercular syphilides. Besides these eruptions pigmentation may occur (pigmentary syphilide), and blood may extravasate (purpuric syphilide).

Prince A. Morrow does not believe in erecting the vesicular syphilides into a special group. He tells us that vesicles

sometimes form on erythematopapular lesions, but their presence is an accident and not a regular phenomenon. So, too, the bullous syphilide is a rare accident in a case, and even when it occurs soon becomes pustular. The pemphigoid syphilide is found almost exclusively in hereditary disease.[1]

1. **Erythema** (*maculæ, roseola,* or *spots*). This eruption usually comes on gradually, crop after crop of spots appearing, and many days passing before an extensive area is covered. Occasionally, however, it arises suddenly (after a hot bath, after taking violent exercise, or after eating an indigestible meal). This eruption consists of circumscribed irregularly round, hyperemic spots, about one-eighth of an inch in diameter, whose color does not entirely disappear on pressure in an old eruption but does in a recent one. The color is at first light pink, but it becomes red, purple, or even brown. In the papular form of erythema the spots are slightly elevated. Erythema is rare upon the face and the dorsum of the hands and feet. It attacks especially the chest and belly, but appears often on the forehead, the bend of the elbow, and the inner portion of the thigh, the neck, and the flexor surface of the forearms and arms. It appears first on the abdomen and last on the legs. Usually erythema follows syphilitic fever, about six weeks after the chancre appears, and the number and distinctness of the spots are in proportion to the violence of the fever. No fever or slight fever means there will be but few spots and they will soon disappear. In rare cases the eruption is very transitory, lasting but a few hours, but it usually continues for several weeks if untreated. It may pass away or may be converted into a papular eruption. Mercury will cause it to disappear in a couple of weeks. In examining for this form of eruption in a doubtful case, let cold air blow upon the chest and belly (Hearn); this blanches the sound skin and makes clear any discoloration. No desquamation attends the macular eruption, but a brownish stain remains for a variable time after the eruption fades. Erythema means, as a rule, a mild and curable attack. Maculæ may be combined with the next form, constituting a maculopapular eruption.

The maculopapular syphilides are evolved from the macular syphilides. They are slighly elevated, are situated upon hyperemic bases, and the summits of some of them may undergo slight desquamation. A roseolar area may show one or several of these macular papules. They are apt to arrange

[1] Morrow's *System of Genito-urinary Diseases, Syphilology, and Dermatology.*

themselves in segments of a circle, and are symmetrically distributed. This eruption usually appears early, but may appear late. It may fade and reappear several times in the same patient. The eruption lasts a few weeks.

2. **Papular syphilides,** which are papules or elevations covered with dry skin, may or may not desquamate. If they do desquamate, the process begins over the center. They usually appear from the third to the sixth month of the disease. They may be preceded by fever, and often reappear again and again. They are at first red, but become brownish. They are firm in feel and vary in size from the head of a pin to a five-cent piece or larger. They may be present as miliary papules, lenticular papules, papules which scale off (papulosquamous eruption), and moist papules. Papules on fading leave coppery-looking stains. Papules upon the palms and soles constitute the so-called "palmar and plantar psoriasis," which appears from three months to one year after the appearance of the chancre. Papules just below the line of the hair on the forehead constitute the *corona venerea*. Papular syphilides appear especially upon the forehead, the neck, the abdomen, and the extremities. The papular or squamous syphilide of the palms and soles begins as a red spot which becomes elevated and brownish; the epidermis thickens and is cast off, and there then remains a central red spot surrounded by undermined skin. If papules are in regions where they are kept moist (as about the anus), they become covered with a sodden gray film which after a time is cast off and leaves the papule without epidermis. The sodden papules are called "flat condylomata," moist or humid papules or plates. Papules which are at first small may become large. The small or miliary papules constitute syphilitic lichen. The lenticular papules are most common, and strongly tend to scale off. The papular syphilides give a worse prognosis for the constitutional disease than do spots.

3. **Pustular syphilides** arise from papules. The condition is known as *acne* when the apex of a papule softens, *impetigo* when the whole papule suppurates, and *ecthyma* or *rupia* when the corium is also deeply involved. Vesicles occasionally precede pustules. The pustular eruption appears a number of months after infection and later than the papular. The pustular eruption gives a very bad prognosis for the constitutional disease. Rupia is formed by a pustule rupturing or a papule ulcerating, the secretion drying and forming a conical crust which continually increases in height and diameter, while the ulceration extends at the edges. When the crust

is pulled off there is seen a foul ulcer with congested, jagged, and undermined edges. Rupia may be secondary or tertiary, and it invariably leaves scars. It appears only after at least six months have passed since the chancre began. Secondary rupia is symmetrical. Tertiary rupia is asymmetrical.

4. **Tubercular syphilides** are greatly enlarged papules intermediate between ordinary papules and gummata.

Diagnosis between Secondary and Tertiary Syphilides.—A secondary eruption is distinguished from a tertiary eruption by the following: the first tends to disappear, the second tends to persist and to spread; the first is general and symmetrical, the second is local and asymmetrical; the first does not spread at its edge, the second tends to spread at its edge, and this tendency, which is designated "serpiginous," produces an ulcer shaped like a horseshoe (Jonathan Hutchinson). Secondary lesions appear within certain limits of time, develop regularly, and are dispersed by mercurial treatment. Tertiary lesions appear at no fixed time, develop irregularly, and are not cleared up by mercury.

Affections of the Mucous Membranes.—The chief lesions in syphilitic affections of the mucous membranes are mucous patches, warts, and condylomata. The first phenomena of secondary syphilis are, as a rule, symmetrical ulcers of the tonsils, painless, of temporary duration, and superficial (Hutchinson). The borders of the ulcers are gray, and the areas are reniform in shape. Catarrhal inflammations often occur. Eruptions appear on the mucous membranes as upon the skin. Mucous patches are papules deprived of epithelium; they are gray in color, are moist, and give off an offensive and virulent discharge. They usually appear as areas of congestion, swelling, and abrasion of the epidermis upon the lips, palate, gums, tongue, cheeks, vagina, labia, vulva, scrotum, anus, and under the prepuce. A moist papule of the skin is really a mucous patch. These patches, which are always circular or oval, are among the most constant lesions of the secondary stage, appearing from time to time during many months. If a patch has the papillæ destroyed, it is called a "bald patch." If the papules present hypertrophied papillæ fused together, there appear enlargements with flat tops, termed "condylomata;" if the papillæ of the papules hypertrophy and do not fuse, the growths are called "warts." Mucous lesions of the mouth are commonest in smokers and in those with bad or neglected teeth. Hutchinson says that persistence in smoking during syphilis may cause leukomata, or persistent white patches. The vagina and lips

of the vulva during the secondary stage are often covered with mucous patches. The uterus may contain mucous lesions which poison the uterine discharge. The larynx may suffer from inflammation, eruptions, and ulceration (hence the hoarse voice which is so usual). The nasal mucous membrane may also suffer. The rectal mucous membrane may be attacked with patches, and so may the glans penis, the inner surface of the prepuce, and the urethra. Early in the secondary stage in some cases there is a slight muco-purulent urethral discharge, and examination with an endoscope shows redness of the mucous membrane of the anterior urethra. The discharge is contagious. The condition may be followed by constriction of the urethral caliber. Distinct ulceration may take place.

Affections of the Hair.—In syphilis the hair is usually shed to a great extent. This loss may be widespread (beard, mustache, head, eyebrows, pubic hair, etc.) or it may be limited. Complete baldness sometimes ensues, but it is rarely permanent. The hairs of the head are first noticed to come out on the comb; on pulling them they are found loose in their sheaths—so loose that Ricord has said "a man would drown if a rescuer could pull only upon the hair of the head." The falling out of the hair, which is known as "alopecia," usually begins soon after the fever or about the time of the eruption, but it may be postponed much later. The skin of a syphilitic bald spot is never smooth, but is scaly. The hair may thin generally, baldness may appear in twisting lines, or it may be complete only in limited areas. Alopecia results from shrinking of the hair-pulp, death of the hair, and casting off of the sheath.

Affections of the Nails.—Paronychia is inflammation and ulceration of the skin in contact with a nail and extending to the matrix. The nail is cast off partially or entirely. Onychia is inflammation of the matrix, and is manifested by white spots, brittleness or extended opacity, twisting, and breaking off of the nail. The parts around are not affected. The damaged nail drops off and another diseased nail appears.

Affections of the Ear.—Temporary impairment of hearing in one or both ears is not uncommon in syphilitic affections of the ear. Rarely, permanent symmetrical deafness is produced. Ménière's disease is sometimes caused by syphilis.

Affections of the Bones and Joints.—In syphilis there may be slight and temporary periostitis. Pain and

tenderness arise in various bones, the pain being worse at night (osteocopic pains). Osteoperiostitis usually arises with or after the onset of the secondary eruption, but in rare instances precedes the syphilides. The bones usually involved are the tibiæ, clavicles, and skull. Intense headache may be due to periostitis of the inner surface of a cranial bone (Mauriac). Local periostitis may form a soft node which by ossification becomes a hard node. Pain like that of rheumatism affects the joints. Symmetrical synovitis has been noted. Secondary syphilitic disease of bone, periosteum, and joints lasts only a short time and is never destructive.

Affections of the Eye.—Iritis is the commonest eye trouble which may arise during secondary syphilis. It appears from three to six months after the chancre, and begins in one eye, the other eye soon becoming affected. The symptoms are a pink zone in the sclerotic, a congested, red or muddy iris, irregularity of the pupil accentuated by atropin, the existence of pain and photophobia, and sometimes hazy or even clouded pupil. Rheumatic iritis causes much pain and photophobia, syphilitic iritis comparatively little; there is less swelling in the first than in the second; the former tends to recur, the latter does not. Iritis is usually recovered from, good vision being retained. Diffuse retinitis and disseminated choroiditis never occur until a number of months have passed since the infection. The symptoms are failure of sight, muscæ volitantes, and very little photophobia. The diagnosis of retinitis and choroiditis is made by the ophthalmoscope.

Affections of the Testes.—Syphilitic Sarcocele.—The testicle enlarges because of plastic inflammation. Both glands usually suffer, but not always. Fluid distends the tunica vaginalis. The epididymis escapes. The testicle is not the seat of pain, is troublesome because of its weight, and has very little of the proper sensation on squeezing. The plastic exudate is generally largely absorbed, but it may organize into fibrous tissue, the organ passing into atrophic cirrhosis.

Intermediate Period.—Secondary lesions cease to appear in from eighteen months to three years. In the intermediate period no symptoms may appear, but the disease is still for some time latent and is not cured. Symptoms may appear from time to time. These symptoms, which are called "reminders," are not so severe as tertiary symptoms; are apt to be symmetrical, and do not closely resemble secondary lesions. Among the reminders we may name palmar psoriasis and sarcocele. Sarcocele in this stage is bilateral and rarely painful. Bilateral indolent epididymitis occasionally

occurs. Sores on the tongue, a papular skin-eruption, and choroiditis may arise. Gummata occasionally occur in this stage, but they are apt to be symmetrical and non-persistent. Arteritis may occur, beginning in the intima or adventitia, and causing, it may be, aneurysm, thrombosis, or embolism. Obliterative endarteritis may cause gangrene. Vascular changes are notably common in the vessels of the brain, and thrombosis may occur, in which case a paralysis comes on gradually, preceded by numbness, although sudden paralysis may take place. These paralyses may be limited, extensive, transitory, or permanent. The nervous system often suffers in this stage (anesthetic areas and retinitis). The viscera are often congested and infiltrated (tonsils, liver, spleen, kidneys, and lungs).

Tertiary Syphilis.—This stage is not often reached, the disease being cured before it has been attained. It is not so much a stage of syphilis as a condition of impaired nutrition which results from the disease. This view finds confirmation in the fact that tertiary lesions do not furnish the contagion. The primary stage disappears without treatment, the secondary stage tends ultimately to spontaneous disappearance, but tertiary lesions tend to persist and to recur. Tertiary lesions may be single or may be widely scattered; when multiple they are not symmetrical except by accident. These lesions may attack any tissue, even after many years of apparent cure; they all tend to spread locally, they all leave permanent atrophy or thickening, they all tend to relapse, and a local influence is often an exciting cause.

Tertiary skin-eruptions are liable to ulcerate. Various eruptions may occur: papular syphilides, pustular syphilides, gummatous syphilides, serpiginous syphilides, and pigmentary syphilides. The characteristic syphilide is *rupia*, which is formed by a pustule rupturing or a papule ulcerating. A brown or black crust forms because of the drying of the discharge, ulceration continues under the crust, new crusts form, and, as the ulcer is constantly increasing peripherally, the new crusts are larger in diameter than the old ones, and the mass assumes the form of a cone. An ulcer which has destroyed the deeper layers of the skin is exposed by tearing off the crust. On healing the rupial ulcers always leave a permanent scar.

Serpiginous ulcers are common in tertiary syphilis, and are especially common about the knees, nostrils, forehead, and lips. Serpiginous ulceration is spoken of as syphilitic lupus. It is preceded by a widespread, brown-colored nodular cuta-

neous infiltration. The nodules suppurate, run together, crust, and produce an ulcer which spreads rapidly and becomes the shape of a horseshoe.

The Gumma.—The gumma is the typical tertiary lesion. A gumma arises from an inflammation the products of which are unable to organize for want of sufficient blood-supply, and consequently undergo fatty degeneration. A gumma presents a center of gummy degeneration, a surrounding area of immature fibrous tissue, and an outer zone of embryonic tissue and leukocytes. A gumma, when it is spontaneously evacuated, exhibits a small opening or many openings with very thin red and undermined edges; the ulcer is slow to heal, and forms a thin scar, white in the center, but pigmented at the margins and usually depressed (Jonathan Hutchinson, Jr.). The gummatous ulcer is deep, circular in outline, with undermined edges and an uneven floor covered with a thick white adherent slough. Sometimes there is no slough, but an extensive area is infiltrated. A gummatous ulcer may coalesce with one or more adjacent ulcers. The discharge is scanty and tenacious. These ulcers are often seen upon the legs, and when once healed rarely recur. A gumma in the internal organs may become a fibrous mass. Gummata form in the skin, subcutaneous tissues, muscles, tongue, joints, bursæ, testes, spinal cord, brain, and internal organs. In tertiary syphilis an inflammation may not form a circumscribed gumma, but, in stead, may produce a diffuse degenerating mass. This type of inflammation, which is seen in bones, is called "gummatous." A healing gumma in a mucous canal such as the rectum or larynx causes thickening and stricture. Tertiary syphilis is a common cause of amyloid degeneration and the most frequent cause of arterial and nervous sclerosis.

Various Lesions.—Hutchinson enumerates the lesions of tertiary syphilis as follows: *Periostitis*, forming nodes or causing sclerotic hypertropy or suppuration or necrosis; gummata in various parts; disease of the skin of the type of rupia or lupus; gumma or inflammation of the tongue, causing sclerosis; structural changes in the nervous system, causing ataxia, ophthalmoplegia externa and interna, general paresis, optic atrophy, and paralyses of cerebral nerves; amyloid degenerations; and chronic inflammation of certain mucous membranes (of the mouth, pharynx, vagina, rectum, etc.), with thickening and ulceration. Gummatous osteoperiostitis of the vertebræ may arise, and this may be associated with disease of the membranes or cord. Syphilitic inflammation of

vertebræ is called syphilitic spondylitis. Unilateral enlargement of the epididymis is sometimes noted, the mass feeling heavy, aching a little, but not being very tender. Unilateral sarcocele may be met with.

Visceral Syphilis.—In visceral syphilis the lungs may undergo fibroid induration (syphilitic phthisis). Syphilitic phthisis is a nonfebrile malady. Gummata may form in the heart, liver, spleen, or kidneys. The capsule and fibrous septa of the liver may thicken, the organ being puckered by contraction. Amyloid changes may appear in any of the viscera. Albuminuria may occur in tertiary syphilis. It may be caused by fibroid changes in the kidneys, by the formation of gummata, or by amyloid degeneration. Its occurrence should be watched for. Mercury and iodid of potassium have been regarded as causative of albuminuria in some cases.

Syphilis may cause disease of the stomach, and probably does so more frequently than was formerly supposed, because it is difficult to distinguish from more common diseases. The condition may be gummatous infiltration of the walls of the stomach, multiple and minute gummata, ulcerations resulting from breaking down of gummata, or syphilitic endarteritis of the gastric vessels. When ulcers heal cicatricial contraction results. Syphilitic ulcers and gummata may be cured by efficient antisyphilitic treatment. Like lesions may form in the intestines.

Flexner, Mracek, Fränkel, Fournier, and others have discussed this subject.[1]

Nervous syphilis may be manifested in disorders of the brain, cord, or nerves. Brain syphilis is usually a late phenomenon (from one to thirty years after infection), and is more apt to appear after light than after severe secondaries. The lesion may be gumma of the membranes (tumor), gummatous meningitis, arterial atheroma, or obliterative endarteritis. A gumma may eventuate in a scar, a cyst, or a calcareous mass. The symptoms of brain syphilis depend on the nature, seat, and rate of development of the lesions. It is to be noted that syphilitic palsy is apt to be limited, progressive, and incomplete. Epilepsy appearing after the thirtieth year is very probably specific if alcohol as a cause can be ruled out (Wood). Persistent headache, tremor, insomnia or somnolence, transitory, limited, and erratic palsies, unnatural slowness of utterance, amnesia, vertigo, and epilepsy are very suggestive of syphilis. Sudden ptosis is very significant; so is sudden palsy of one or more of the extrinsic eye-muscles.

[1] See editorial in *Jour. Amer. Med. Assoc.*, March 24, 1900.

In syphilitic insomnia the patient cannot get to sleep at night for a long while, but when he once gets to sleep he reposes well. The type of insanity which is most apt to arise is a likeness or counterpart of general paralysis, and, like ordinary paresis, it is not curable. Spinal syphilis may cause sclerosis, a condition like Landry's paralysis, softening, and tumor. Neuritis is not uncommon in syphilis. Many of the lesions which follow syphilis are due to it only indirectly, and are not benefited by specific treatment. We speak of such conditions as parasyphilitic diseases. Among them are paresis and locomotor ataxia.

Justus's Test for Syphilis.—The test consists in first estimating the amount of hemoglobin present, then making a single mercurial inunction, and again estimating the hemoglobin. It is claimed that the corpuscles of an untreated syphilitic are unduly sensitive, and if the disease is present a mercurial inunction will cause a loss of 10 to 20 per cent. of hemoglobin, which fall persists for a few hours. The absolute value of this test is somewhat doubtful. It is often demonstrable in secondary, tertiary, or congenital syphilis. This test usually fails in latent cases and in early secondary syphilis.[1]

Treatment of Primary Stage.—A chancre should not be excised. The disease is constitutional when the chancre appears, and excision and cauterization inflict needless pain and do no good. The initial lesion should never be cauterized unless it is phagedenic or becoming so. Order the patient to soak the penis for five minutes twice daily in warm salt water (a teaspoonful of salt to a cupful of water), and then to spray the sore with peroxid of hydrogen (14-volume solution of peroxid diluted with an equal bulk of water) from an atomizer. The ulcer is then dried with absorbent cotton and on it is dusted a powder composed of equal parts of bismuth and calomel. The buboes in the groin require no local treatment unless they tend to suppurate. If they persist or become large, paint them with iodin or rub ichthyol ointment or mercurial ointment into them, and apply a spica bandage of the groin. Some authorities give mercury in this stage, in order to prevent secondaries. The younger Gross opposed this strongly, and affirmed a wish to see the secondary eruption—first, because it proves the diagnosis; and, second, because it affords valuable prognostic indications (an erythematous eruption means a light case; an early pustular eruption means a grave case with serious complications). I have always followed the plan of Gross, and do not order

[1] D. H. Jones, *N. Y. Med. Jour.*, April 7, 1900.

mercury until constitutional symptoms develop. If phagedena arises, place the patient at once upon stimulants and nutritious diet, secure sleep, and destroy the ulcer by the use of nitric acid or the electric cautery while the patient is anesthetized. After cauterization with iodoform, dress with wet antiseptic gauze. Several times a day change the dressings, and at each change spray with peroxid of hydrogen, irrigate with bichlorid of mercury solution, and dust with iodoform. It may be necessary to cauterize several times. In some cases it will be necessary to employ continuous irrigation with an antiseptic fluid. These cases are sometimes fatal and usually produce great destruction of tissue. In chancre redux watch carefully for the development of symptoms, in order to determine if the condition is really one of reinfection or if we are dealing with a gumma which resembles a chancre in appearance.

Treatment of Secondary Stage.—In the secondary stage the aim is to cure the disease. That it can be cured is known from the fact that reinfection occurs in some persons. The old axiom, "Syphilis once, syphilis ever," is not true. Mercury must be used, the form being a matter of choice. Fournier first advocated intermittent treatment. In this plan give gr. $\frac{1}{3}$ of protiodid of mercury daily for six months, then stop a month; then give mercury for three months, then stop two months. During the first year the patient is under treatment nine months, and during the second year eight months. Some prefer the intermittent and others the continuous plan of treatment. In following the continuous plan find the patient's tolerance to mercury, and keep him for two years on daily doses below the amount he will tolerate. Gross's rule for continuous treatment was to order pills of the green iodid of mercury, each pill containing gr. $\frac{1}{5}$. The patient was ordered one pill after each meal to begin with; the next day the after-breakfast dose was increased to two pills; the following day the after-dinner dose was two pills, and so on, one pill being added every day. This advance was continued until there was slight diarrhea, griping, a metallic taste, or tenderness on snapping the teeth together, whereupon one pill was taken off each day until all unfavorable symptoms disappeared. This experimentation finds a dose on which the patient can be kept with entire safety for a long time; but if it is found that colic or diarrhea is apt to recur, there must be added to each pill gr. $\frac{1}{12}$ of opium. The patient is given mercury in this way for two years. Every time new symptoms appear the dose

is raised, and as soon as they disappear it is lowered to the standard. If the protiodid is not tolerated, give the bichlorid:

> ℞. Hydrarg. chlor. corros., gr. j;
> Syr. sarsaparillæ comp., f℥iij.—M.
> Sig. f℥, in water, after meals.

Mercury with chalk in 1- or 2-grain doses four times a day, with or without Dover's powder in 1-grain doses, may be used. Mercurial inunctions produce a rapid effect, but irritate the skin. The drug should be rubbed in with a gloved hand. There can be used once a day $\frac{1}{2}$ dram of oleate of mercury (10 per cent.) or 1 dram of mercurial ointment, rubbed into the skin. The first day it is rubbed into the inside of one thigh, the second day into the inside of the other thigh; the third day into the inside of one arm; the fourth day into the other arm; next, into one groin and then into the other groin, and then inunction is again made at the point of original application, and so on. After the rubbing the patient puts on underclothes and goes to bed, and in the morning takes a bath. The ointment may be smeared on a rag, which is then worn between the stocking and sole of the foot during the day.

Fumigation is performed by volatilizing each night ʒj of calomel. The patient sits naked on a cane-seat chair, and is wrapped up to the neck in a blanket which drops tent-like to the floor; the calomel is put upon an iron plate under the chair, and is heated by an alcohol lamp beneath the plate. The skin becomes coated with calomel, and the subject, after putting on woollen drawers and an undershirt, gets into bed. Hypodermatic injections of mercury are used by some physicians. They cause an eruption to disappear rapidly, but may produce abscesses, and relapses are prone to occur. Orville Horwitz has recently made thorough trial of the hypodermatic method, and arrives at the following conclusions: it will not abort the disease; it should never be a routine treatment; in suitable cases it is very valuable for symptomatic use, as when lesions on the face or in important structures make a rapid impression desirable or necessary; in cases which obstinately relapse under other treatment, and in syphilis of the nervous system. J. William White, after a large experience with this method, says that hypodermatic injections of corrosive sublimate are painful and are strongly objected to by many patients; that this method of treatment is occasionally dangerous and even fatal; that it is liable to be followed by local complications (erythema,

nodosities, cellulitis, abscess, sloughing); that it cannot be carried out by the patient, but requires the surgeon's constant intervention. This syphilographer concludes that hypodermatic medication does not offer advantages justifying its use as a systematic method of treatment, and that it encourages insufficient treatment—those "short heroic courses" which Hutchinson shows are followed by the gravest tertiary lesions. "The claim that by a few injections the time of treatment can be measured by months or even by weeks, instead of by years, would seem, as Mauriac has said, to involve the idea that mercury given hypodermatically acquires some new and powerful curative property which, given in other ways, it does not possess."[1] The usual plan is to give daily a hypodermatic injection of corrosive sublimate deep into the back or buttock, the dose being gr. $\frac{1}{4}$ of the drug. Thirty such injections are used unless some contraindication demands their discontinuance sooner. The treatment is then stopped. If the symptoms recur, however, the patient is given another course, the daily dosage being gr. $\frac{1}{6}$, the treatment being again stopped after thirty injections, but continued anew in $\frac{1}{8}$-grain doses if the symptoms recur. The use of gray oil hypodermatically has warm advocates. It is claimed that it provokes but little pain and irritation, and that it is a very efficient remedy. The oil must be warmed and shaken before being used. Lang injects gr. $\frac{3}{4}$ to gr. $1\frac{1}{2}$ of the 50 per cent. gray oil, or twice this quantity of the 30 per cent. oil, twice during the first week, once during the second week, and after this once a week or once every other week for an indefinite period of time. It may be given oftener if symptoms arise or persist.

Taylor believes that gray oil may give rise to unpleasant and sometimes even to dangerous symptoms, and it should be used with extreme care and only in selected cases in which other remedies are contraindicated. He says that in reading about the hypodermatic method he has been struck with the fact that "the most serious results have almost invariably followed injections in which fatty matters have been the vehicle of suspension."[2]

Some surgeons employ intravenous injections of mercury. Lane injects, at first every other day and later daily, 20♏ of a 1 per cent. solution of cyanid of mercury. The skin in front of the elbow is rendered aseptic, a fillet is tied around

[1] J. William White, in Morrow's *System of Genito-urinary Diseases, Syphilology, and Dermatology.*

[2] *Venereal Diseases*, by Robert W. Taylor.

the arm, the needle is inserted into a vein, the fillet is loosened, the fluid is injected, and the needle is withdrawn. This method of using mercury is painless and produces a rapid effect. It may be used in nervous syphilis, but should not be used as a routine. In whatever way mercury is given, do not allow it to produce salivation (hydrargyrism or ptyalism). Always remember that mercury may cause albuminuria and examine the urine at regular intervals during a course of the drug. If albumin appears in the urine, cut down the dose of mercury or stop the drug for a time. In the beginning of a case of syphilis, if the kidneys are found to be diseased, give the mercury cautiously, and never fail to examine the urine at regular intervals.

Acute Ptyalism, or Salivation.—In acute ptyalism the saliva becomes thick and excessive in amount; the gums become tender (found first by snapping the teeth), spongy, and tend to bleed; a metallic taste is complained of; the breath becomes fetid; the oral structures swell; the teeth loosen; the saliva is produced in great quantity; and there are purging, colic, and exhaustion. Sometimes there are fever and a diffuse scarlatiniform eruption upon the skin. A chronic hydrargyrism may be shown by salivation, gastro-intestinal disorder, emaciation, mental depression, weakness, albuminuria, and tremor. To avoid salivation, advance the dose with great caution and instruct the patient as to the first signs of the trouble. He should use a soft tooth-brush and an astringent mouth-wash (gr. xlviij of boric acid to ℥iv each of Listerine and water). When ptyalism is noted, discontinue the administration of the drug. Employ the above mouth-wash or one composed of a saturated solution of chlorate of potassium. Order gr. $\frac{1}{120}$ of atropin twice a day, and in bad cases spray the mouth with peroxid of hydrogen and use silver nitrate locally (gr. xx to ℥j). Give stimulants (iron, quinin, and strychnin) and nutritious food. A weekly Turkish bath is of great service. In chronic hydrargyrism stop the administration of the drug, use tonics, stimulants, open-air exercise, Turkish baths, and nutritious food. The chlorid of gold and sodium forms a substitute for mercury. The use of iodid of potassium is of questionable value in ptyalism.

Treatment of Complications in the Secondary Stage.—The complications of the secondary stage usually require local applications in addition to general remedies. Mucous patches in the mouth should be touched with bluestone every day, an astringent mouth-wash being employed several times daily. If the patches ulcerate, they should be touched

once a day with lunar caustic; if these areas proliferate, they should be excised and cauterized. Vegetations or growing papules on the skin must, if calomel powder fails to remove them, be cut away with scissors and be cauterized with chromic acid or with the Paquelin cautery. Condylomata demand washing with ethereal soap several times daily, thorough drying, dusting with equal parts of calomel and subnitrate of bismuth or with borated talcum, and covering with dry bichlorid gauze. If these simple procedures fail, excise and cauterize.

For psoriasis of the palms and soles diachylon ointment, mercurial plaster or painting with tincture of iodin should be employed. Ulcers of paronychia are dressed with iodoform and corrosive-sublimate gauze. Deep cutaneous ulcers are cleaned once a day with ethereal soap, sprayed with peroxid of hydrogen, dressed with iodoform and corrosive-sublimate gauze and bandaged. When the process of granulation is well established dress with 1 part of unguent. hydrarg. nitratis to 7 parts of cosmolin. In sarcocele mercurial ointment should be rubbed into the skin of the scrotum or the testicle be strapped. In alopecia the hair should be kept short, and every night the scalp should be cleaned with equal parts of green soap and alcohol rubbed into a lather with water. After the soap has been washed out some hair tonic should be rubbed into the scalp with a sponge. A favorite preparation of Erasmus Wilson's consisted of the following ingredients:

℞. Ol. amygd. dil.,
Liq. ammoniæ, *āā* f℥j;
Sp. rosemarini,
Aquæ mellis, *āā* f℥iij.—M.
Ft. lotio.

One part of tincture of cantharides to 8 parts of castor oil may be rubbed into the scalp. Solutions of quinin are esteemed by some.

In treating persistent skin-lesions, inunctions, injections, fumigations or mercurial baths may be used. Baths are suited to patients with delicate skins, to those whose digestion fails when mercury is given by the mouth, and to those whose lungs will not tolerate fumigations. Half an ounce of corrosive sublimate with 4 scruples of sal ammoniac are mixed in about 4 ounces of water; this is added to a bath at a temperature of 95° F. The patient gets into this bath, covers the tub with a blanket, leaving only his head

exposed, and remains in the bath an hour or so. Mercurial baths may rapidly cause salivation.

In every case of syphilis, no matter what constitutional or local treatment is used, the general health of the patient must be watched and the use of tobacco stopped, as its employment renders certain the development of mucous patches and causes them to persist. The use of alcohol as a beverage must be interdicted: it is to be employed only as a medicine for debility and weakness of assimilation. An open-air life to a great degree must be insisted upon, and care observed as to protection from damp and cold. Flannels must be worn in winter. Every morning the patient should sponge the chest and shoulders with cold or tepid water and then with alcohol, and dry himself with a rough towel. He should take a hot bath twice a week, or a Turkish bath once a week. He should wash the anus and nates after every stool, and ought to dust the axillæ, scrotum, perineum, and internatal region once a day with borated talcum. The teeth are to be looked to and put in perfect order, a soft brush being used twice a day and an astringent mouth-wash being frequently employed. The diet must contain liberal amounts of meat and milk. The patient should be weighed weekly: any falling off in weight is an indication for the administration of tonics, concentrated food, and cod-liver oil. If a patient's health continues to fail during a mercurial course, the drug should be stopped for some time and the patient be treated with iron, chlorid of gold and sodium, hot baths, fresh air, cod-liver oil, and nourishing foods. In treating secondary syphilis, give mercury for at least eighteen months and better for two years. Reminders require mixed treatment (mercurials and iodids).

Tertiary Stage.—If at any time during the case there appear tertiary symptoms, the patient should be put on mixed treatment. In any case, after two years of mercury add iodid of potassium to the treatment. White's rule is to use mixed treatment for at least six months (if any symptoms appear), the six-months course dating from their disappearance. This emphasizes the fact that the iodids alone will not cure tertiary syphilis. In obstinate tertiary lesions and in nervous syphilis the iodids should be run up to an enormous amount (from 30 to 250 grains per day). Sometimes people can take large doses of iodid when small doses produce iodism. Cyon explains this curious fact as follows: small doses combine with some products of the thyroid gland and form toxic iodo-thyrin. Large doses are diuretic, form soluble salts, and are rapidly eliminated. An easy way to give iodid is to

order a saturated solution each drop of which equals one grain of the drug. Each dose of the iodid is given one hour after meals and in at least half a glass of water. If the iodid disagrees, it may be given in water containing one dram of aromatic spirit of ammonia or in milk. The iodid of sodium may be tolerated better than the potassium salt, or the iodids of sodium, potassium, and ammonium may be combined. In giving the iodids begin with a small dose. During a course of the iodid always give tonics and insist on plenty of fresh air. Arsenic given daily tends to prevent skin-eruptions. The iodids when they disagree produce iodism —a condition which is made manifest by a flow of mucus from the nose, conjunctival irritation, a bad taste in the mouth, exhaustion, anorexia, nausea, and tremor. In some subjects there are outbreaks of acne, vesicular eruptions, or even bullæ or hemorrhages. Iodism calls for the abandonment of the drug, and the administration of increasing doses of Fowler's solution, of arsenic, of laxatives, of diuretic waters, or if there is great exhaustion, of stimulants. In some cases belladonna is of service. Some patients who cannot take the alkaline iodids may take syrup of hydriodic acid. After the patient has been for six months under mixed treatment without a symptom, stop all treatment and await developments. If during one year no symptoms recur, the patient is probably cured; if symptoms do recur, there must be six months more of treatment and another year of watching. Fournier has insisted that it is a great wrong to tell a syphilitic that he can never marry. He must not marry until he is cured, and he is not cured until, after the cessation of the use of iodid, he goes one year without treatment and without symptoms.

Hereditary Syphilis.—Transmitted congenital syphilis is a hereditary syphilis manifest at birth. Acquired syphilis (except in the case of a woman who obtains the disease from a fetus) always presents the chancre as an initial lesion; hereditary syphilis never does. Hereditary syphilis may present itself at birth, and usually shows itself within, at most, the first six months of extra-uterine life. In rare cases (tardy hereditary syphilis) the disease does not become manifest until puberty.

Rules of Inheritance.—According to von Zeissl,[1] the rules of inheritance are as follows:

1. If one parent is syphilitic at the time of procreation, the child may be syphilitic.

[1] *Pathology and Treatment of Syphilis.*

2. Syphilitic parents may bring forth healthy children.

3. If a mother, healthy at procreation, bears a child syphilitic from the father, the mother must have latent pox or must be immune, having become infected through the placental circulation. She often shows no symptoms, having received the poison gradually in the blood, and having thus received, it may be said, preventive inoculations. Certain it is that mothers are almost never infected by suckling their syphilitic children (Colles's law).

4. If both parents were healthy at the time of procreation, and the mother afterward contracts syphilis, the child may become syphilitic, and the earlier in the pregnancy the mother is diseased, the more certain is the child to be tainted. This is known as "infection in utero."

5. The more recent the parental syphilis, the more certain is infection of the offspring. The children are often stillborn.

6. When the disease is latent in the parents it is apt to be tardy in the children.

7. The longer the time which has passed since the disappearance of parental symptoms, the more improbable is infection of the children.

8. In most instances parental syphilis grows weaker, and after the parents beget some tainted children they bring forth healthy ones.

Syphilis in the mother is more dangerous to the offspring than syphilis in the father. The frequent immunity of the mother is due to the fact that her tissues produce antitoxins under the influence of the slowly absorbed virus.

Many women who labor under hereditary syphilis are sterile. Many syphilitic women abort, usually before the eighth month, most commonly in the fifth month. The fetus very often dies at an early period of gestation. This may be due to a gummatous placenta or to a degeneration of placental follicles.

Evidences of Hereditary Syphilis (manifest at, or oftener soon after, birth).—Hutchinson says that at birth the skin is almost invariably clear. In from six to eight weeks "snuffles" begin, which are soon followed by a skin-eruption, by body-wasting, and by a chain of secondary symptoms (iritis, mucous patches, pains, condylomata, etc.). The child looks like a withered-up old man. Eruptions are met with on the palms and soles. Intertrigo is usual. Cracks occur at the angles of the mouth, and leave permanent radiating scars. The abdomen is tumid, and there is apt to be exhausting

diarrhea. The secreting and absorbing glands of the intestinal tract atrophy.[1] Enlargement of spleen and liver occurs. Sometimes synovitis or arthritis arises. Atrophic lesions may appear in the bones. In the skull the bone may be softened by removal of its salts or be thinned by the pressure of the brain. In the long bones the epiphyseal lines suffer, the attachment of the epiphyses to the shafts is weak, and separation is easily induced. Epiphysitis is common, rarely causes pain, and rarely leads to suppuration, except in children who are old enough to walk (Coutts). Osteophytic lesions of the skull are shown by symmetrical spots of thickening upon the parietal and frontal bones (natiform skulls). In the long bones osteophytes are frequently formed. A child with precocious hereditary syphilis is apt to die, but if it lives from six months to one year the symptoms for a time disappear and for years the disease may be latent. Diagnosis is difficult after the third or fourth year, especially if the disease be associated with rickets or tuberculosis. When later symptoms arise they may be various, namely: noises in the ears, often followed by deafness; interstitial keratitis; dactylitis (specific inflammation of all the structures of a finger); synovitis in any joint; ossifying nodes; developmental osseous defects; suppurative periostitis; ulcerations; death of bone; falling in of the nose; nervous maladies; occasionally sarcocele, etc. In hereditary syphilis the eye-symptoms are of great diagnostic importance. In 212 cases of congenital syphilis Fournier found eye-trouble in 101. Keratitis and choroiditis are the most usual forms (Silex). Bone-trouble occurs in almost half of the cases, but is not often severe enough to cause symptoms. The tongue often shows a smooth base (Virchow's sign). Hirschberg believed choroiditis to be pathognomonic. The descendants of syphilitic parents may exhibit certain pathological conditions which are not directly syphilitic. Fournier calls such phenomena parasyphilitic. Among these phenomena are arrest of development of the body at large or of special structures, weakness of constitution, and stigmata of degeneration.

Diagnosis.—In the diagnosis of hereditary syphilis the condition of the teeth is of considerable importance: the temporary teeth decay soon, but present no characteristic defect. If the upper permanent central incisors are examined, they are often but by no means always found defective. Other teeth may show defects, but in these alone are characteristic defects

[1] Coutts, in *Brit. Med. Jour.*, 1894, No. 1643.

likely to appear. In hereditary syphilis they may present an appearance of marked deviation from health, and are then called "Hutchinson teeth" (Fig. 66). If they are dwarfed, too short and too narrow, and if they display a single central cleft in their free edge, then the diagnosis of syphilis is probable. If the cleft is present and the dwarfing absent, or if the peculiar form of dwarfing be present without any conspicuous cleft, the diagnosis may still be made. The view that teeth of this nature prove the existence of hereditary syphilis and that they occur only in syphilis has been abandoned by Hutchinson himself. In fact, only one-fifth of congenital syphilitics have these teeth and one-third of the cases of Hutchinson teeth are in individuals free from syphilis. In early infancy the diagnosis of syphilis is made by the snuffles, the broad nose, the skin-eruptions, the wasted appearance, the sores at the mouth-angles, the tenderness over bones, condylomata, and the history of the parents. The diagnosis at a later period is made by the existence of symmetrical interstitial keratitis, choroiditis, the smooth base of the tongue, deafness which comes on without pain or running from the ear, ossifying nodes, white radiating scars about the mouth-angles, sunken nose, natiform skull, deformity of long bones, painless inflammation of epiphyses, and Hutchinson teeth. It must be remembered that a child born apparently healthy and presenting no secondary symptoms may show bone-disease, keratitis, or syphilitic deafness at puberty.

FIG. 66.—Hutchinson teeth.

Treatment.—In infants mercurial inunctions are to be used until the symptoms disappear, but mercury must not be forced or be continued too long after the symptoms are gone. There must be rubbed into the sole of each foot or the palm of each hand 5 grains of mercurial ointment every morning and night. Brodie advised spreading the ointment (in the strength of ʒj to the ounce) upon flannel and fastening it around the child's belly. If the skin is so tender that mercury must be administered by the mouth, order that gr. $\frac{1}{12}$ to gr. $\frac{1}{2}$ of mercury with chalk, with 1 grain of sugar, be taken three times a day after nursing. If tertiary symptoms appear, and in any case when the secondaries disappear, give gr. ss to gr. j or more of iodid of potassium several times a day in syrup. White advocates the continuance of the mixed treatment intermittently until puberty. Local lesions require local

treatment, as in the adult. A syphilitic child must be nursed by its mother, as it will poison a healthy nurse. If the baby has a sore mouth, it must be fed from a bottle; and if the mother cannot nurse the child, it must be brought up on the bottle. For the cachexia use cod-liver oil, iodid of iron, arsenic, and the phosphates.

XVII. TUMORS OR MORBID GROWTHS.

Division.—Morbid growths are divided into (1) neoplasms and (2) cysts.

Neoplasms.—A neoplasm is a pathological new growth which tends to persist independently of the structures in which it lies, and which performs no physiological function. A hypertrophy is differentiated from a tumor by the facts that it is a result of increased physiological demands or of local nutritive changes, and that it tends to subside after the withdrawal of the exciting stimulus. Further, a hypertrophy does not destroy the natural contour of a part, while a tumor does. Inflammation has marked symptoms: its swelling does not tend to persist, it terminates in resolution, organization or suppuration, and examination of a section under the microscope differentiates it from tumor. Inflammation, too, has an assignable exciting cause. A new growth is a mass of newly formed tissue; hence it is improper to designate as tumors those swellings due to extravasation of blood (as in hematocele), or of urine (as in ruptured urethra), to displacement of parts (as in hernia, floating kidney, or dislocation of the liver), or to fluid distention of a natural cavity (as in hydrocele or bursitis).

Classes of Tumors.—There are two classes of tumors; the first class includes those derived from or composed of ordinary connective tissue or of higher structures. These all originate from cells which are developed from the mesoblast. There are two groups of connective-tissue tumors: (*a*) the typical, benign, or innocent, which find their type in the healthy adult human body; and (*b*) the atypical or malignant, which find no counterpart in the healthy adult human body, but rather in the immature connective tissues of the embryo.

The second class of tumors include those which are derived from or composed of epithelium: (*a*) the typical, or innocent, composed of adult epithelium; and (*b*) the atypical, or malignant, composed of embryonic epithelium.

Müller's Law.—Müller's law is that the constituent ele-

ments of neoplasms always have their types, counterparts, or close imitations in the tissues, either embryonic or mature, of the human body.

Virchow's Law.—Virchow's law is that the cells of a tumor spring from pre-existing cells. There is no special tumor-cell or cancer-cell.

The term "heterologous" is no longer used to signify that the cellular elements of a tumor have no counterpart in the healthy organism, but is employed to signify that a tumor deviates from the type of the structure from which it takes its origin (as a chondroma arising from the parotid gland). Tumors when once formed almost invariably increase and persist, though occasionally warts, exostoses, and fatty tumors disappear spontaneously. Tumors may ulcerate, inflame, slough, be infiltrated with blood, or undergo mucoid, calcareous, or fatty degeneration.

Causes.—The causes of tumors are not positively recognized, those alleged being but theories varying in probability and ingenuity.

The inclusion theory of Cohnheim supposes that more embryonic cells exist than are needful to construct the fetal tissues, that masses of them remain in the tissues, and that these may be stimulated later into active growth. The embryonic hypothesis seems to receive a certain force from the facts that exostoses do sometimes develop from portions of unossified epiphyseal cartilage, and that tumors often arise in regions where there was a suppression of a fetal part, closure of a cleft, or an involution of epithelium (epithelioma is usual at mucocutaneous junctions). This theory, which does not explain the origin of most neoplasms, cannot successfully be maintained even as a common predisposing cause.

Hereditation is extremely doubtful. S. W. Gross found hereditary influence by no means frequent in cancer of the breast. It is affirmed by some, denied by others, and doubted by a number. At most, hereditary influence may only predispose. Nevertheless, cases have occurred which cannot be explained by the term coincidence. In the celebrated "Middlesex Hospital case," a woman and five daughters had cancer of the left breast. A. Pearce Gould had charge of a woman for cancer of the left breast. The mother of this patient, the mother's two sisters, and two of the mother's cousins had died of cancer. Power reports a remarkable instance of family predisposition to cancer. A patient had his right breast removed for cancer in 1896. In 1897 can-

cerous glands were removed from the axilla. In 1898 he was seen again with an irremovable recurrent growth. His father died of cancer of the breast. He had two brothers, one of whom died of cancer of the throat when sixty-five years of age, the other having died of cancer of the axilla when he was only twenty-four years old. Of his eight sisters, four died of cancer of the breast, and the two who are living both suffer from cancer of the breast. One sister died when an infant, and one died after giving birth to a child.[1]

Injury and inflammation may undoubtedly prove exciting causes. A blow is not infrequently followed by sarcoma; the irritation of a hot pipe-stem may excite cancer of the lip; the scratching of a jagged tooth may cause cancer of the tongue; chimney-sweeps' cancer arises from the irritation of dirt in the scrotal creases; and warts often arise from constant contact with acrid materials.

Physiological activity favors the development of sarcoma, and *physiological decline* favors the development of carcinoma.

Parasitic Influence.—This theory does not maintain that the tumor is the parasite, but that it contains the parasite, although Pfeiffer and Adamciewicz did at one time assert that a cancer-cell is not a body-cell, but a parasite resembling an epithelial cell. Some facts render a parasitic origin of malignant growths not improbable; as, for instance, the likeness of some tumors to infective granulomata, their occasional secondary development in distant parts of the body, the resemblance of the secondary to the primary growths, and the tenacity of their persistence. A parasitic origin of cancer is pointed to by its geographical distribution, the disease being very common in low and marshy districts (Haviland).

Some surgeons believe that cancer is contagious, but most observers deny it. Guelliott, of Rheims, believes that cancer is primarily a local infection. He believes this because Morea and Hanau have inoculated it from one animal to another of the same species, and if this can be brought about experimentally he sees no reason why it cannot happen accidentally. This surgeon says that cancer is very unequally distributed, that genuine cancer-centers and "cancer-houses" exist, and that numerous cases of accidental infection have occurred.[2] Mayet, of Lyons, holds that cancer can be reproduced by grafting or by the injection of cancer-fluid. Graf could not find "cancer-houses" after a careful

[1] *Brit. Med. Jour.*, July 16, 1898.
[2] *Am. Jour. Med. Sci.*, June, 1895.

search.[1] Geissler claims to have produced the disease in a dog by planting fragments of cancer in the subcutaneous tissue and vaginal tissue, but Czerny, Rosenbach, and others dispute the claim. Hauser disputes the assertion that cancer must be an infectious disease because it is followed by secondary growths. Secondary growths in an infectious disease are caused by the bacterium; secondary growths in cancer are caused by the transferrence of cells of the primary growth.[2] Hauser says with truth that the close connection between innocent and malignant growths renders the parasite view untenable, because to hold it we would be forced to believe that every tumor has a special parasite or that one parasite may cause many kinds of tumor.

There seems to be no doubt that autotransference of cancer can occur, although it rarely does so. Sippel has reported a case in which vaginal carcinoma developed at the point where the vagina was in contact with a pre-existing cancer of the portio.[3] Cornil has seen cancer transferred from one of the labia majora to the other, and from one lip to the other. Geissler was unable to transplant cancer, and Gratia also failed in his attempts. Duplay and Bazin say that transmissibility is possible, but only under conditions which are not practically realized. Haviland believes strongly in "cancer-houses."[4]

Tillmanns elaborately discussed the subject of cancer in the Congress of 1895. His conclusions seem most sound and scientific. He says there is no evidence of a bacterial origin of cancer. The parasitic origin has not been proved, and protozoa have not certainly been found. Cancer can be transferred from one part to another part of the same individual, or from one individual to another of the same species, but never to one of a different species. It is possible that cancer can spread by contagion; this is very rare, but can happen (as when penile cancer is followed by cervix cancer in a wife). Because it is sometimes possible to transfer cancer, this does not prove that the disease is parasitic or infectious; it simply shows that *tissue* has been successfully transplanted.

Actinomycosis, long thought to be a true tumor, is now known to arise from the ray-fungus. There can be no doubt that changes in the liver which practically constitute a new growth can arise from the growth of a cell called by Darier

[1] *Archiv f. klin. Chir.*, 1895, l., p. 144.
[2] Hauser, in *Biolog. Centralbl.*, Oct. 1, 1895.
[3] *Centralbl. f. Gynäk.*, No. 4, 1894.
[4] *Lancet*, April 27, 1894.

the "psorosperm." A disease due to psorosperms is called a "psorospermosis." It is affirmed by some that molluscum contagiosum, follicular keratosis, cancer, and Paget's disease are due to psorosperms. Some claim to find the parasite in all cases of cancer, while others can find it in only 4 or 5 per cent. of the cases.

Heneage Gibbes affirms[1] that dilatation of the bile-ducts of a rabbit's liver is caused by the chronic irritation arising from multiplication of the coccidium oviforme in them, and not in the columnar cells of the bile-ducts, as has been stated; and, further, that the large majority of glandular cancers show nothing that can be considered parasitic, the suspicious appearances noted in some few cases being due to endogenous cell-formation. The coccidium oviforme is a genus of the sporozoa, class protozoa, the lowest division of the animal kingdom. To this class belong the monera and infusoria.

Malignant and Innocent Tumors.—Malignant growths infiltrate the tissues as they grow; benign tumors only push the tissues away; hence malignant tumors are not thoroughly encapsuled, while innocent tumors are encapsuled. Malignant tumors grow rapidly; innocent tumors grow slowly. Malignant tumors become adherent to the skin and cause ulceration; innocent tumors rarely adhere and rarely cause ulceration. Many malignant tumors give rise to secondary growths in adjacent lymphatic glands (cancer, except in the esophagus and antrum of Highmore, always does so); sarcoma rarely causes them, unless the growth be melanotic or unless it arises from the testicle or tonsil. Innocent tumors never cause secondary lymphatic involvement, although the glands near the tumor may enlarge from accidental inflammatory complications. The malignant tumors, especially certain sarcomata and soft cancers, may be followed by secondary growths in distant parts and various structures (bones, viscera, brain, muscles, etc.); innocent tumors are not followed by these secondary reproductions, although multiple fatty tumors or multiple lymphomata may exist. Malignant tumors destroy the general health; innocent tumors do not unless by the accident of position. Malignant tumors tend to recur after removal; innocent tumors do not if operation was thorough. The special histological feature of a malignant growth is the possession by its cells of a power of reproduction which knows no limit, the cells of the tumor living among the

[1] *The American Journal of Medical Sciences*, July, 1893.

body-cells like a parasite, and invading and destroying the body-cells.

Classification.—Tumors may be classified as follows:

I. Connective-tissue tumors.

1. Innocent tumors, or those composed of mature connective tissue:

   Lipomata, or fatty tumors; *fibromata*, or fibrous tumors; *chondromata*, or cartilaginous tumors; *osteomata*, or bony tumors; *odontomata*, or tooth-tumors; *myxomata*, or mucous tumors; *myomata*, or muscle-tumors; *neuromata*, or tumors upon nerves; *gliomata*, or tumors composed of neuroglia; *angiomata*, or tumors formed of blood-vessels; *lymphangiomata*, or tumors formed of lymphatic vessels. The term lymphoma, meaning a tumor of a lymphatic gland, was formerly applied to any hypertrophy of a lymphatic gland, no matter whether caused by syphilis, tubercle, or Hodgkin's disease. The term has been abandoned except as expressing enlargement of a gland, and does not convey any suggestion as to the cause.

2. Malignant tumors, or those composed of embryonic connective tissue:

   Sarcomata (including endotheliomata) and adrenal tumors.

II. Epithelial tumors.

1. Innocent tumors, or those composed of mature epithelial tissue:

   Adenomata, or tumors whose type is a secreting gland; and *papillomata*, or tumors whose type is found in the papillæ of skin and mucous membranes.

2. Malignant tumors, or those composed of embryonic epithelial tissue:

   Carcinomata, or cancers.

Innocent Connective-tissue Tumors.—These growths mimic or imitate some connective tissue or higher tissue of the mature and healthy organism.

Lipomata are congenital or acquired tumors composed of fat contained in the cells of connective tissue, which cells are bound together by fibers. If the fibers are excessively abundant, the growth is spoken of as a "fibrofatty tumor." A fatty tumor has a distinct capsule, tightly adherent to surrounding parts, but loosely attached to the tumor; hence enucleation is easy. Fibrous trabeculæ run from the capsule of a subcutaneous lipoma to the skin; hence movement of

the integument over the tumor or of the tumor itself causes dimpling of the skin. An ordinary circumscribed lipoma is of doughy softness, is lobulated, of uniform consistence, and on being tapped imparts to the finger a tremor known as pseudofluctuation. A fatty tumor is mobile, although it may be attached to the skin at points by trabeculæ. Lipomata are most frequent in middle life, and their commonest situations are in the subcutaneous tissues, especially of the back or of the dorsal surfaces of the limbs; they usually occur singly, but may be multiple and sometimes symmetrical. Senn described the case of a woman who had a fatty tumor in each axilla. A lipoma may grow to an enormous size (in Rhodius's case the tumor weighed sixty pounds), and the growth may be progressive or may be at times stationary and at other times active. The skin over a fatty tumor sometimes atrophies or even ulcerates; the tumor itself may inflame or partly calcify. When a lipoma has once inflamed it becomes immovable. Subcutaneous lipoma of the palm of the hand or sole of the foot bears some resemblance clinically to a compound ganglion; it is apt to be congenital. Lipomata of the head and face are rare. In the subcutaneous tissues of the groins, neck, pubes, axillæ, or scrotum a mass of fat may form, unlimited by a capsule and known as a "diffuse lipoma." A diffuse lipoma may dip down among the muscles. Such masses attain large size. The typical diffuse lipoma is occasionally seen on the neck. It begins back of the mastoid process on one side or on both sides. When large, it completely surrounds the neck, a huge double chin forming in front, a great mass hanging on each side, and the posterior portion being divided into two halves by a median depression. A nevolipoma is a nevus with much fibrofatty tissue. A very vascular fatty tumor is called lipoma telangiectodes. If the tumor stroma contains large veins, the growth is called a cavernous lipoma. A tumor containing much blood can be diminished in size by pressure. Fatty tumors may arise in the subserous tissue, and when such a growth arises in either the femoral or inguinal canal or the linea alba it resembles an omental hernia and is spoken of as a "fat-hernia." In the retroperitoneal tissues enormous fibrofatty tumors occasionally grow, and these neoplasms tend to become sarcomatous. Lipomata may arise from beneath synovial membranes and will project into the joints, being still covered by synovial membrane. Fatty tumors occasionally arise in submucous tissues, between or in muscles, from periosteum, and from the meninges of the spinal cord (J.

Bland Sutton). A fatty tumor may undergo metamorphosis. The stroma may be attacked by a myxomatous process or a calcareous degeneration. The fat-cells themselves may become calcareous. Oil-cysts sometimes form. A xanthoma is a growth composed of fatty tissue in and about which there is marked infiltration with small cells. Such a tumor is flattened and slightly elevated. Several or many of these growths occur in the same person. The eyelids are the most common seat of xanthoma. The tumor may undergo involution or may become sarcomatous.

Diabetics are liable to develop xanthomata.

Treatment.—A single subcutaneous lipoma should be extirpated. The capsule must be incised, when the tumor can be torn out forcibly or can be enucleated by dissection; drainage is always employed for twenty-four hours, as butyric fermentation will be apt to occur, and necrosis of small particles of fat predisposes to infection. Multiple subcutaneous lipomata, if very numerous, should not be interfered with unless troublesome because of their size or situation, when the growth or growths causing trouble should be removed. It is difficult to extirpate entire a diffuse lipoma, and several operations may be needed to effect complete removal. Liquor potassæ has been recommended to limit the growth of multiple lipomata or diffuse lipoma; it may be taken internally for a considerable time, but it seems to be useless. Subperitoneal lipomata are rarely diagnosticated until the belly has been opened or the growth has been removed.

Fibromata are tumors composed of bundles of fibrous tissue. There are two forms, the hard and the soft. A hard fibroma consists of wavy fibrous bundles lying in close contact. Here and there connective-tissue corpuscles exist between the fibres. A fibroma has no distinct capsule, though surrounding tissues are so compressed as to simulate a capsule. Fibromata are occasionally congenital, are most usual in young adults, but they may occur at any period of life, and in any part of the body containing connective tissue. Pure fibromata, which are rare, are generally solitary, grow slowly, are of uniform consistence, have not much circulation, and are hard and movable. Fibromata may form upon nerves, they may arise in the mammary gland, they may develop in the lobe of the ear, and they may spring from various fibrous membranes, from the periosteum of the base of the skull (nasopharyngeal fibromata), and from the gums (fibrous epulides). A soft fibroma contains

much areolar tissue, the spaces of which are filled with fluid, so that the tissue seems edematous. Soft fibromata grow from the skin, mucous membranes, subcutaneous tissue, intermuscular planes, and periosteum. Soft fibromata are especially apt to arise from the skin of the scrotum, labia, inner surface of arm and thigh, and of the belly wall of a pregnant woman. They are not unusually multiple, grow slowly but more rapidly than the hard fibromata, and may become quite large and possess distinct pedicles. Fibromata may become cystic, calcareous, osseous, colloidal, or sarcomatous, and may inflame, ulcerate, or even become gangrenous.

A *painful subcutaneous tubercle*, which is a form of fibroma commonest in females, arises in the subcutaneous cellular tissue, usually of the extremities. It is firm, very tender, movable, rarely larger than a pea, and the skin over it seems healthy. Violent pain occurs in paroxysms and radiates over a considerable area, of which the tubercle is the center. These paroxysms may occur only once in many days or many times in one day. Pain is always developed by pressure, and may be linked with spasm. Nerve-fibrillæ are now known to exist in these tubercles, a fact which was long denied.

A *mole* is a congenital fibroma of the skin (Senn). It is rounded or flat, is usually pigmented, is apt to have hairs growing from it, and varies in size from a pin's head to several inches in diameter. The tumor rarely grows after the thirteenth or fourteenth year. A mole may become malignant, melanotic carcinoma may arise from its epithelial structures, or melanotic sarcoma from its connective-tissue elements.

Fibrous epulis is a fibroma arising from the gums or peri-odontal membrane (J. Bland Sutton) in connection with a carious tooth or retained snag; it is covered by mucous membrane, grows slowly, may attain a large size, and sometimes has a stem, but is more often sessile. It may undergo myxomatous change or may become sarcomatous.

Fibrous tumors may arise from the ovary, the intestine, and the larynx. Pure fibromata of the uterus are very rare, but fibromyomata are very common (see Myomata, p. 278); hence the term "uterine fibroid" should be abandoned.

Molluscum fibrosum is an overgrowth of the fibrous tissue of both skin and subcutaneous structure. Senn excludes this form of growth from consideration with fibromata because of its infective origin. It may be limited or widely extended; it may appear as an infinite number of nodules scattered over the entire body or as hanging folds of fibrous tissue in certain areas. *Keloid* is a fibroma of the true skin.

It is a hard, fibrous, vascular growth, with a broad base, arising in scar-tissue; it is crossed by pink, white, or discolored ridges, and is named from a fancied likeness to the crab. It occasionally but rarely attacks mucous membrane. It is more common in negroes than in whites, and is most frequent in the cicatrices of burns, though it may arise in the scar of any injury, as the scar from piercing the ears, and in the scars of syphilitic lesions, tubercular processes, small-pox, or vaccination. It is rare in early childhood and in old age. It grows slowly, lasts for many years, and may eventually undergo involution and disappear. It is useless to remove keloid by operation, as it will promptly return. The fibrous tissue of keloid springs from the outer walls of the blood-vessels (Warren). The papillæ of the skin above the tumor are destroyed or replaced by fibrous tissue.

Morphea, spontaneous or true keloid, is a name used to designate a growth of this description which does not arise from a scar; but it seems certain that scar-tissue was present, though possibly in small amount from trivial injury.

Fibrous and papillomatous growths covered with endothelium may spring from any serous membrane. Such a growth of the choroid plexus calcifies early and constitutes a psammoma. All psammomata are not fibrous, some are gliomatous and some are sarcomatous. A cholesteatoma is a fibrous growth covered with endothelium and containing layers of crystalline fat. It occurs especially in the pia mater, and is called a pearl tumor.

Treatment.—When in accessible regions fibromata should be enucleated. Fibromata should not be left alone, because any fibrous tumor may become a sarcoma. If a hard fibroma of the skin exists the skin is incised and the tumor is "shelled out." A soft fibroma is removed by an incision carried round the base of its pedicle. A painful subcutaneous tubercle should be excised. If a mole shows the slightest disposition to enlarge, or if it is subjected to pressure or irritation, it should be removed, because if allowed to remain it might develop into a malignant growth. It is often desirable to remove a hairy or pigmented mole, not only because it may become malignant, but also because it is unsightly. Epulis requires the cutting away of the entire mass, the removal of the related snag or carious tooth, and sometimes the biting away of a portion of the alveolus with rongeur forceps. A naso-pharyngeal fibrous polyp usually contains sarcomatous elements or becomes a spindle-cell sarcoma. If it has a

pedicle, it may be removed by the cautery loop. In a severe case a part of the superior maxillary bone is removed by osteoplastic resection to permit of extirpation. Keloid should not be operated upon: it will only return, and will also recur in the stitch-holes. Trust to time for involution, or use pressure with flexible collodion, by which method J. M. DaCosta cured a case following small-pox. The administration of thyroid extract may be of benefit (a gr. v tablet three or four times a day). This drug must be given cautiously, as it may cause attacks characterized by fever, dyspnea, and rapid pulse. Thiosinnamin hypodermatically has been used, it is claimed, with benefit. A 10 per cent. solution is made, and from 10 to 15 minims can be injected into the gluteal muscles every third day.

Chondromata (enchondromata) are tumors formed either of hyaline cartilage, of fibrocartilage, or of both. Chondromata are apt to arise from certain glands, the long bones, the pelvis, the rib-cartilages, and the bones of the hands or feet, and often spring from unossified portions of epiphyseal cartilage. They may be single or multiple, and are most commonly met with in the young. They have distinct adherent capsules; they grow slowly, and if of osseous origin progressively hollow out the bones by pressure; they cause no pain; they impart a sensation of firmness to the touch, unless mucoid degeneration forms zones of softness or fluctuation; they are inelastic, smooth or nodular, immovable, and often ossify. A chondroma may grow to an enormous size. A chondroma of the parotid gland or testicle practically always contains sarcomatous elements, and any chondroma may become a sarcoma. Chondromata are notably frequent in persons who had rickets in early life. *Ecchondroses*, which are "small local overgrowths of cartilage" (J. Bland Sutton), arise from articular cartilages, especially of the knee-joint, and from the cartilages of the larynx and nose. Loose or floating cartilages in the joints may be broken-off ecchondroses or portions of hyaline cartilage which are entirely loose or are held by a narrow stalk, and which arise by chondrification of villous processes of the synovial membrane; only one or vast numbers may exist; one joint may be involved, or several; they may produce no symptoms, but usually produce from time to time violent pain and immobility by acting as a joint-wedge. An ecchondroma may arise within the medullary canal of a long bone, from foci of dormant cartilage, and may lead to the development of a solitary cyst of large size by softening of the

tumor. The femur is the most usual site of disease. It begins very insidiously and progresses gradually. There are slight lameness, trivial pain, tenderness below the level of the trochanter, apparent shortening and some bulging of bone. The bone may bend or at some spot may thin so that the cyst can be felt. Such a bone fractures from slight force, and after a fracture, when the effused blood and inflammatory exudate have been absorbed, a tumor can be distinctly detected. A solitary cyst of a long bone is apt to be regarded clinically as a sarcoma (Bergmann-Virchow).

Treatment.—Remove chondromata whenever possible, for, if allowed to remain undisturbed, they are apt to resent this hospitality by becoming sarcomatous. Incise the capsule and take away the growth, using chisels and gouges if necessary. Incomplete removal means inevitable recurrence. Amputation is very rarely demanded. Loose bodies in the joints, if productive of much annoyance, are to be removed, the joint being opened with the strictest antiseptic care. Amputation is sometimes performed for a solitary cyst of a long bone, the surgeon having looked upon the growth as sarcomatous. If a correct diagnosis is arrived at, an attempt should be made to remove the cyst without amputation. Bergmann succeeded in extirpating such a mass from the femur.

Osteomata.—Osteomata are tumors which are composed of osseous tissue. J. Bland Sutton says that osteomata are ossifying chondromata. Osteomata take origin from bone, cartilage, connective tissue, especially tissue near the bone, serous membrane, and certain glands and organs. Compact osteomata, which are identical in structure with the compact tissue of bone, arise from the frontal sinus, mastoid process, external auditory meatus, and other regions in those beyond middle life; they are small, smooth, round, densely hard, with small and occasionally cartilaginous bases.

Cancellous osteomata, which comprise the great majority of bone-tumors, are similar in structure to cancellous bone. They spring from, and are crusted with, cartilage; they may have fibrous capsules, and are often movable when recent, but soon become fixed; they have broad bases, are angled, nodular, firm (but not so hard as are the compact osteomata), painless except when pressed, occur particularly at the ends of long bones, may grow to large size, and are commonest in youth. Osteomata near joints become overlaid by bursæ, which in rare instances communicate with an adjacent joint.

The term *exostosis* has been used as being synonymous with

osteoma, but wrongly so, as an exostosis is an irregular, local, bony growth which does not tend to progress without limit, and which is, hence, not a tumor. A true exostosis is seen in the ossification of a tendon-insertion, in a limited growth from one of the maxillary bones, and in a local growth from the last phalanx of the big toe, which latter form of growth is known as a "subungual exostosis." Exostoses of the retrocalcaneal bursa occasionally arise when this bursa is inflamed. Inflammation of this bursa is known as Achillodynia or Albert's disease. The bony masses sometimes found in the brain, lungs, testicle, various glands, and tumors are not true osteomata. Osteomata do not tend to become malignant and do not recur after removal.

Treatment.—Osteomata which are non-productive of pain or trouble do not demand removal. If they produce pain by pressure, if they press upon important structures, if they cause annoying deformities, or if they grow rapidly, then remove them by means of chisels, gouges, or the surgical engine. Subungual exostosis should always be removed. The nail should be split and part of it taken away, and the bony mass be gouged away or be cut off with forceps.

Odontomata[1] are tumors composed of tooth-tissue. They spring from the germs of teeth or from developing teeth. J. Bland Sutton divides them into (1) those springing from the follicle; (2) those springing from the papilla; and (3) those springing from the whole germ.

Epithelial odontomes, or **multilocular cystic tumors,** arise from the follicle, occur oftenest in the lower jaw, dilate the bone, have capsules, and are made up of masses of cysts which are filled with brown fluid. These cysts are met with most frequently before the age of twenty. *Follicular odontomes,* or *dentigerous cysts,* oftenest spring from the follicles of the permanent molars. In a dentigerous cyst there exists an expanded follicle which distends the bone, the follicle being filled with thick fluid and containing a portion of a tooth. A *fibrous odontome* is due to thickening of the tooth-sac, which prevents eruption of the tooth; fibrous odontomes are usually multiple, and are apt to occur in rickety children. A *cementome* is due to enlargement, thickening, and ossification of the capsule, the developing tooth being encased in cement. A *compound follicular odontome* is due to ossification of portions only of an enlarged and thickened capsule, and the tumor contains bits of

[1] This section is abridged from J. Bland Sutton's striking chapter upon odontomes in his recent work on *Tumors.*

cementum, portions of dentine, or small misshapen teeth. A *radicular odontome* springs from the papilla and arises after the crown of the tooth is formed and while the roots are forming; hence it contains dentine and cement, but no enamel. *Composite odontomes* are formed of irregular, shapeless masses of dentine, cement, and enamel. All the above forms occur in man. They present themselves as hard tumors associated with teeth or in an area where teeth have not erupted. Occasionally an odontome simulates necrosis; it is surrounded by pus, and a sinus forms.

Treatment.—The diagnosis is scarcely ever made until after incision; hence, be in no haste to excise large portions of bone for a doubtful growth; incise first and see if it be an odontome, which requires only the removal of an implicated tooth, curetting with a sharp spoon, and packing with iodoform gauze.

Myxomata are tumors composed of mucous tissue. They are rare as independent growths, although myxomatous change is frequent in the stroma of other tumors. The tissue type of these tumors is found in the vitreous humor of the eye and in the perivascular tissues of the umbilical cord (Wharton's jelly). Bowlby states that myxomata are in reality soft fibromata whose intercellular substance has been replaced by mucin. The myxomatous state may be a stage in the formation of a fibroma, a stroma not having developed. Myxomata may result from myxomatous degeneration of cartilage, of muscle, or of fibrous tissue. These tumors are soft, elastic, usually pedunculated, tremulous, and vibratory. The stroma is very delicate and carries minute blood-vessels. Cutting into a myxoma causes a straw-colored, clear jelly to exude; they grow slowly, are encapsuled, have but little circulation, and the diagnosis may be impossible before removal of the growth. Some pathologists place myxomata among the malignant tumors, but most consider them as benign tumors, though they tend strongly to become sarcomatous (myxosarcomata). A sarcoma may undergo myxomatous degeneration.

Myxomata may arise from the skin; from the mucous membrane of the nose, the frontal sinus, the antrum, the womb, the auditory meatus, and the tympanum (gelatinous polyps); from the parotid and mammary glands; from the subcutaneous tissue, the nerve-sheaths, the intermuscular septa, the rectum, and the bladder (polyps). They may be congenital, but occur most often in young adults, as a result of inflammation. A sudden increase of growth indicates

beginning malignancy (sarcomatous change). When a tumor begins to undergo myxomatous transformation we give to it a compound name; for instance, a chondroma undergoing myxomatous change is a chondromyxoma, a fibroma undergoing a like change is a fibromyxoma, etc.

Mucous polypi grow from the mucous membrane of the nose, particularly from the outer wall near the middle turbinated bone, and often from the roof of the nose. Mucous polypi are soft and jelly-like, of a grayish color, and have stems or pedicles; they may be seen through the anterior nares, may project behind the veil of the palate, and may bulge out from the passages of the nose; they may be, and usually are, multiple; they may be present in one nasal fossa or in both; and they occur most commonly in youths and adults between the ages of fifteen and thirty-five years.

Hydatid moles of pregnancy are due to myxomatous changes in the chorion.

Treatment.—In treating myxomata, remove them promptly and thoroughly, because of the danger of sarcomatous change. Polyps of the bladder are removed by means of cutting-forceps after suprapubic cystotomy has been performed. Nasal polyps may usually be twisted off or be removed by the wire snare or galvanocautery. Occasionally when the growths are numerous and recur rapidly after removal, the inferior turbinated bones should be removed with a saw (Rouge's operation). This operation secures ready access to the area of disease, which can be attacked radically. A very soft myxoma breaks up when removal is attempted, and the base must be cauterized.

Myomata are tumors composed of unstriped muscle-fiber mixed often with fibrous tissue (leiomyomata). Tumors composed of striated muscle-fiber and spindle-cells (rhabdomyomata) are very rare and are always sarcomatous. Leiomyomata are found in the womb, in the prostate gland, in the walls of the gullet, vagina, stomach, bladder, and bowel, in the broad ligament, ovary, and round ligament, in the scrotum, and in the skin. Myomata usually begin during or after middle age; they are encapsuled, they grow slowly, they are firm and hard, and produce annoyance by their size and weight or by obstructing a viscus or channel. A leiomyoma of the posterior portion of the middle of the prostate gland is known as "a middle lobe."

The so-called "uterine fibroid" is a myoma or fibromyoma. Uterine myomata may originate within the walls of the womb (intramural myomata), from the muscular

structure of the mucous lining (submucous myomata), or from the muscular tissue of the serous covering (subserous myomata). Intramural uterine myomata may be single or multiple and may grow to an enormous size. Submucous myomata project into the cavity of the womb (fleshy polyps), and may project into the vagina. They distend the uterus and are often accompanied by menorrhagia or metrorrhagia. In some rare cases the projecting tumor is detached by Nature and the patient is cured; in some cases the myoma becomes gangrenous. A fleshy polyp may produce inversion of the fundus of the womb. Subserous uterine myomata cause trouble only by the inconvenience of weight or the discomfort of pressure. Uterine myomata are commonest in single women, and arise most frequently between the ages of twenty-five and forty-five. Negro women are especially prone to develop such tumors. They may never produce any symptoms. Some of these growths, by enlarging until they ascend above the pelvic brim, produce abdominal distention; some become jammed or impacted in the pelvis, and produce by pressure retention of urine, obstruction to the passage of feces, or hydronephrosis. Impaction may occur temporarily at each menstrual period. Many myomata produce uterine hemorrhage; some cause retroversion of the womb; some protrude from the cervical canal; some are so large that they cause disastrous pressure upon the colon (obstruction), upon the iliac veins (intense edema), or upon the ureters (hydronephrosis). Uterine myomata usually shrink after the menopause. Pregnancy in a myomatous womb usually ends in abortion. Uterine myomata may undergo fatty, calcareous, or myxomatous change, and may be infected by septic organisms as a result of the use of a uterine sound or of infection of the pedicle after oöphorectomy. Infection of a uterine myoma causes great enlargement, elevated temperature, sweats, and exhaustion.

The symptoms of myomata of the alimentary canal are similar to or identical with the symptoms of malignant growths. Myomata of the skin are rare growths; they are encapsuled, firm or elastic, and painless.

Treatment.—Cutaneous myomata are removed in the same manner as fibrous tumors. Uterine myomata are treated by rest and the administration of ergot, barium chlorid, and dilute sulphuric acid. If this treatment fails to arrest serious bleeding due to a fleshy polyp, dilate the cervical canal and remove the growth. If there be dangerous bleeding in a

woman who has some years to wait for the menopause and who has not a removable polyp as the cause, perform oöphorectomy in order to bring on an artificial menopause. When a myoma becomes impacted at each menstrual period remove the ovaries and Fallopian tubes. Subserous myomata may be removed from the uterus after abdominal section, the resulting wound in the uterus being sutured. Hysterectomy is indicated for some very large tumors, for tumors that grow after the menopause, and for infected myomata. If the abdomen be opened to perform oöphorectomy, and the tubes and ovaries are found so implicated in the growth that they cannot be removed completely, or the broad ligament is found so drawn out that a safe pedicle cannot be secured, perform a hysterectomy.[1] A recent suggestion for the shrinkage of uterine myomata is to ligate both the uterine and ovarian arteries. If a myoma of the prostate cause severe obstruction, perform a suprapubic cystotomy and remove the major portion of the enlarged gland; or make both a suprapubic and a perineal opening, push the gland into the perineum and shell it out with the finger, or make permanent suprapubic drainage.

Neuromata.—A true neuroma springs from nerve-tissue (brain, cord, or nerve-trunks); it is composed of medullated or non-medullated nerve-fibers which form a plexus or network, and which are not continuous with the fibers of the nerve-trunk or other area from which the tumor grows. True neuromata, which are rare growths, arise during middle life; they are small in size, are due to injury or hereditary tendency, and they may be single or multiple. There is usually around the tumor, rather than in it, severe neuralgic pain, which is greatly intensified by dampness, by blows, or by rough handling. The parts below a neuroma are cold, swollen, often anesthetic, and frequently present motor paralysis or trophic disorder. A false neuroma or neurofibroma is a fibrous tumor growing from a nerve-sheath, and is identical in structure with the sheath. False neuromata may be single, but they are often multiple; they may be as small as peas or as large as oranges; they are smooth and movable, and may cause great pain or may be painful only when pressed or struck; they may spring from roots, trunks, or branches, and they may be linked with the disease known as "molluscum fibrosum." In plexiform neuroma some branches of a nerve enlarge and lengthen like an artery in a

[1] See J. Bland Sutton's admirable article on "Uterine Myomata" in his work on *Tumors*.

cirsoid aneurysm; the mass feels like beads or like a bag of worms; it is mobile, and no pain is felt on moving it; and it is generally congenital. In plexiform neuroma the nerve-sheath undergoes myxomatous change. Malignant neuroma is a primary sarcoma of a nerve-sheath, though any neuroma may become sarcomatous.

Traumatic neuromata are false neuromata and are occasionally well exhibited after nerve-section or amputation. On nerve-section the distal end shrinks and atrophies, the proximal end enlarges and becomes bulbous. A traumatic neuroma is composed of fibrous tissue which contains nerve-fibers. Such a growth is usually, but not always, painful on pressure or during dampness, and is most commonly seen in a stump which did not heal by first intention. In performing an amputation cut the nerves high up, and thus keep them out of the scar, permit them to remain mobile in their sheaths, and so prevent a tender stump. A tender stump may be due to anchoring of a nerve in a scar, the nerve ceasing to glide when the individual moves the extremity. The condition known as painful subcutaneous tubercle was discussed on p. 272.

Treatment.—A false neuroma is to be removed, if possible, without destroying the nerve-trunk. If, in removing a neuroma, it is necessary to exsect a portion of a nerve-trunk, always endeavor to suture the ends of the divided nerve so as to facilitate restoration of function. For multiple neuromata—at least should the number be large or should molluscum fibrosum exist—surgery can do nothing. Plexiform neuromata may often be removed, but amputation may be required. Painful neuromata in stumps should be excised.

Gliomata.—These tumors are composed of neuroglia, are usually single, and arise in the brain, rarely in the cord, and very rarely in a cranial nerve.

A glioma is a circumscribed growth in contrast to a gliosis, which is a widespread and unlimited hyperplasia of the neuroglia. Syringomyelia is due to gliosis of the spinal cord.

"A glioma consists of cells containing rounded or oval nuclei with very little protoplasm and fine protoplasmic extensions which interlace and form an intercellular reticulum" (Stengel).

A glioma passes insensibly into surrounding tissue, and there is no distinct edge; it is harder than the surrounding tissue; is vascular and of a pink or red color; and the nor-

mal shape of the part is often very little altered, although the tumor may reach the size of a lemon.

Hemorrhage may take place into a glioma, softening may occur, cavities may form, or the growth may become sarcomatous or psammomatous. The symptoms of a glioma of the brain depend on the situation.

Treatment.—When the growth can be localized it is justifiable in some cases to attempt its removal. Even a partial removal may be of benefit.

Angiomata or Hemangiomata.—An angioma is a tumor composed largely of dilated blood-vessels. The older surgeons called such growths erectile tumors. Some of the so-called angiomata are not genuine new growths, but are due to dilatation and elongation of blood-vessels.

Simple or capillary angiomata, nevi, or "mother's marks," which affect the skin or subcutaneous tissue, are composed of enlarged and twisted capillaries and of anastomosing vessels surrounded by fat. These growths are congenital or appear in the first few weeks of life; they are flat and slightly raised, and are of a bright-pink color if composed chiefly of arterioles, and are bluish if composed mainly of venules; they are but little elevated; they can be almost completely emptied by pressure; they occasionally pass away spontaneously, but usually grow constantly and may become cavernous; they may ulcerate and occasion violent or fatal hemorrhage. One or several large vessels connect a nevus to adjacent blood-vessels. Port-wine or claret stains are pink or blue discolorations due to superficial nevi of the skin; they may be small in extent or they may involve a very large area, are not elevated, and do not usually spread. Telangiectasis is a form of nevus involving the skin and subcutaneous tissue in which many arterioles and venules exist. Simple angiomata are common on the forehead, the scalp, the face, the neck, the back, and the extremities. They may appear on the labia, the tongue, or the lips.

Cavernous angiomata, or venous nevi, resemble in structure the corpora cavernosa of the penis; there are large endothelial lined spaces with thin walls carrying blood, and there may be distinct vessels as well. Arteries send blood into the spaces, and veins receive it from the spaces. These channels and sinuses are enormously distended capillaries. Cavernous angiomata arise in the skin and subcutaneous tissues; they are usually congenital, but may develop from simple angiomata; they are purple or blue in color; are

more distinctly elevated than the capillary nevi; may be either cutaneous or subcutaneous; swell when the child cries, and are apt to pulsate; they may be emptied by pressure, and often look like cysts with very thin walls. Cavernous angiomats may arise in the breast, the tongue, the lip, the cheek, the gums, the subcutaneous tissues, or the muscles. If an angioma contains an excess of fat, the growth is called a "nevoid lipoma."

Plexiform angiomata are known as "cirsoid aneurysms" or aneurysms by anastomosis (p. 324).

Angiomata noticed soon after birth may disappear completely or may enlarge progressively.

Treatment.—These growths if large or growing must be treated. A capillary nevus can often be quickly cured by touching it with fuming nitric acid. A second application of acid may be required. The growth may be destroyed by heat—"a knitting-needle at a dull-red heat or the galvanocautery" (Wharton). The application of ethylate of sodium or the employment of electrolysis will destroy the growth. Astringent injections are dangerous unless the base of the nevus is ligated, because they may lead to the formation of emboli.

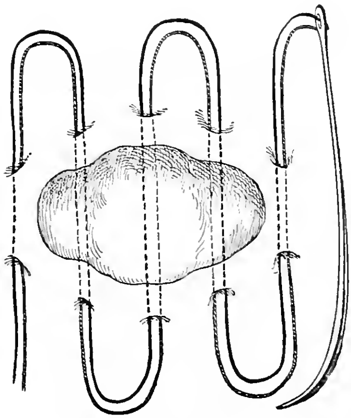


Fig. 67.—Method of applying Erichsen's ligature.

Small port-wine stains may be removed by electrolysis or multiple incisions, but extensive stains are ineffaceable. Small nevi may be ligated under harelip-pins; larger nevi may be strangulated in sections by the Erichsen suture (Fig. 67), or may be completely excised. Excision is usually the best plan for the cure of angiomata. It is rapid, thorough, and leaves but a trivial scar. Excision should always be employed if we feel sure that the edges of the wound can be subsequently approximated and that there will not be a dangerous loss of blood. It is sometimes justifiable to excise an angioma even when approximation of the wound will obviously be impossible. In such a case the raw surface should be covered with Thiersch grafts.

Most superficial nevi and many cavernous angiomata can be treated by excision. The incisions must be beyond the dilated vessels. In large angiomata involving the skin and also deeper parts, or involving a structure, like the lip, which it is undesirable to remove, electrolysis should be employed. The operation should be carried out with aseptic care, and, if the tumor is large, an anesthetic should be given.

The positive pole produces a firm and hard clot. One or more needles connected with the positive pole are inserted in the tumor, and these needles are insulated to within about a quarter of an inch of their points. A flat moist pad is placed upon the skin near the tumor and attached to the negative pole, and the pad is moved from time to time during the operation.

From twenty-five to seventy-five milliampères is the proper strength, and the current is passed for ten minutes. The current is increased for a moment before withdrawing the needles, otherwise they will stick to the tissue and cause bleeding when torn loose. After the withdrawal of the needles the nevus will be found to be hard, but the hardness will gradually disappear. It may be necessary to repeat the operation a number of times at intervals of ten days.[1]

Lymphangiomata are tumors composed of dilated lymph-vessels, and are often, though not invariably, congenital. A lymphatic nevus is a colorless or faintly pink elevation; if it is punctured with a needle, lymph flows from the puncture. One or several nevi may be present in the same individual. The dilatation is due to blocking of the lymph-channels. Local lymphangioma of the tongue is manifested by a cluster of papillary projections containing lymph. Macroglossia is a congenital enlargement of the anterior portion of the tongue, which enlargement grows more and more marked until finally the tongue is forced far out of the mouth. This condition of tongue enlargement is due to lymphangioma of the mucous membrane. Lymph scrotum is due to a similar growth. A collection of these warty-looking dilatations is called lymphangiectasis. Just as cavernous angiomata constitute a variety of blood-vessel tumors, so cavernous lymphangiomata constitute a variety of lymph-vessel tumors, and the spaces of the latter are filled with lymph instead of with blood. Areas affected with lymphangiectasis are liable to repeated attacks of erysipelas-like inflammation. Whether this inflammation is

[1] Cheyne and Burghard's *Manual of Surgical Treatment.*

causative or secondary is not known. In tropical countries blocking of lymph-channels may be brought about by the filaria sanguinis hominis, a parasite which lurks in the lymph-vessels during the day and is found in the blood only at night. Lymphangiectasis is often the first stage of an elephantiasis.

Treatment.—A lymphatic nevus requires excision. In macroglossia the bulk of the mass should be removed by a V-shaped cut, the mucous membrane being sutured so as to cover the stump. In conditions due to the filaria, anilin-blue has been given internally with advantage.

Malignant Connective-tissue Tumors, or Sarcomata.—The sarcomata are composed of embryonic tissue-cells, the intercellular substance being very scanty. They develop from connective tissue, have no definite stroma, and contain no lymphatics, and the constituent cells, as a rule, proliferate with great rapidity. The rapidly growing forms are very vascular, the blood flowing in vessels whose walls are very thin or running in canals lined by endothelium and bounded by sarcomatous cells. Such a tumor may pulsate and have a bruit, and hemorrhage often takes place into its substance. A slow-growing sarcoma has but few vessels. Sarcoma tends strongly to infiltrate adjacent parts. The growth disseminates by means of the blood and the vessel-walls, particles of the tumor being carried by the venous blood to the heart and from this organ to the lungs, where they lodge and form secondary growths. Emboli from these secondary foci are sent out by the arterial blood to various portions of the body, as the bones, kidneys, brain, liver, etc. This process is known as "metastasis." In some cases sarcoma is disseminated widely throughout the body, almost all the tissues showing minute white spots of secondary sarcoma which resemble tubercles. Such widespread dissemination is called sarcomatosis. Sarcoma follows the vein-walls for considerable distances and builds elongated masses of tumor-substance inside the veins. The tumor may possess a capsule when it is in an early stage, but soon loses this except in very slow-growing varieties or in mixed forms growing by central proliferation, but secondary sarcomata are often encapsuled. Sarcomata may arise at any age from birth to extreme senility, but they are commonest during youth and early middle age. They are not hereditary, and often follow traumatism and inflammation. They may be primary or may arise from malignant change in an innocent connective-tissue growth (chondrosarcoma, fibrosarcoma, etc.). A sarcoma does not tend to

affect lymphatic glands except by the accident of its position; and if it does implicate them, the sarcomatous elements are carried rather by the vein-walls and blood than by the lymph (melanotic sarcoma implicates adjacent glands, and so does sarcoma of the tonsil or of the testicle). The skin over the tumor may give way, a bleeding fungus-mass protruding (fungus hæmatodes), and suppuration may cause septic enlargement of adjacent glands. After removal of a sarcoma the growth tends to recur, and the recurrent tumor may be either more or less malignant than its predecessor, the degree of malignancy being in direct ratio to the number and smallness of the cells. A sarcoma is malignant by local tissue-infection and by dissemination. Sarcomata rarely cause pain when they are not ulcerated. They are commonest in the skin and connective tissue of the extremities, but they arise also from bone, neuroglia, periosteum, the lymphatic glands, the breast, the testicle, the eyeball, the parotid, and other parts. Not unusually a pigmented mole becomes sarcomatous. Hemorrhages into a sarcoma often occur, with the result of suddenly increasing its size and forming blood-cysts. Sarcomata are subject to partial fatty degeneration, to myxomatous changes which produce cavities filled with fluid, to calcification, and occasionally to necrosis of large masses.

Varieties of Sarcomata.—The following species of sarcomata are recognized:

1. *Round-celled Sarcoma.*—A tumor composed of round or spherical cells. The intercellular substance is scanty, the mass is soft and vascular, and grows with great rapidity. It often softens, and may become cystic. The cells may be small or large. The smaller the cell the more malignant the growth. A growth composed of small, round cells is the most malignant form of sarcoma. Lymphosarcoma is a form of round-celled sarcoma which arises from lymphatic glands, lymphoid tissues, the thymus gland, and some other structures. The structure of a lymphosarcoma resembles the structure of a lymph-gland. Chloroma is a form of lymphosarcoma, arising particularly from the periosteum of the bones of the cranium and face. The cells contain greenish pigment, hence the name. What is known as glioma of the eyeball is really a sarcoma composed of small round cells.

2. *Spindle-celled Sarcoma.*—A tumor composed of large or small spindle-shaped cells lying in a matrix, which may be homogeneous, but which may show some attempt at

fiber-formation. Angular cells and stellate cells are often present. The cells may be placed in columns, which are at some places nearly parallel, and which at others diverge or interlace. Often there is no orderly arrangement. Spindle-celled sarcomata are usually harder than round-celled growths, but are sometimes quite soft. Cystic changes may occur. If there is a large amount of intercellular substance the growth is known as a fibro-sarcoma. A rhabdomyoma is really a spindle-celled sarcoma containing striated muscle-cells. The spindle-celled sarcomata often contain cartilage. Spindle-celled growths are by no means as malignant as round-celled tumors. Often they do not show any tendency to metastasis. The greater the amount of intercellular substance, and the fewer and smaller the cells, the less the malignancy. Spindle-celled growths constitute the majority of sarcomata met with in practice.

3. *Giant-celled* or *myeloid sarcoma* is characterized by the presence of very large cells, with many nuclei looking exactly like the myeloplaques of bone-marrow. The remainder of the growth is composed of spindle-cells, of round-cells, or of both spindle-cells and round-cells. Such a growth is maroon-colored on section. It arises most usually from bone, especially from the interior of a long bone, hence is often called osteosarcoma. It may, however, arise from other structures than bone. It is the least malignant form of sarcoma. Metastases rarely occur, and the growth often admits of complete extirpation and cure.

4. *Alveolar Sarcoma.*—A tumor containing both round-cells and spindle-cells, and characterized by the formation of acini, filled with round-cells of large size resembling epithelioid cells. The walls of the acini are formed of spindle-cells and fibrous tissue, and in these trabeculæ are the blood-vessels. The collection of the cells into the alveoli makes the structure resemble that of a cancer. Such growths are often pigmented. Alveolar sarcomata arise particularly from moles of the skin, but may arise from lymphatic glands, serous membranes, the testicle, and other parts. Such growths are very malignant.

5. *Melanotic or Black Sarcoma.*—The color of such a tumor is due to pigment in the cells or matrix. These growths are usually composed of round-cells, but may consist of spindle-cells, and they are sometimes alveolar. Melanotic sarcomata spring from parts which contain pigment (the skin and the choroid coat of the eye); they are apt to arise from pigmented moles; they are very malignant; they

implicate related lymphatic glands, and during their existence the urine contains pigment.

6. *Hemorrhagic sarcoma* is a sarcoma containing blood-cysts which result from parenchymatous hemorrhages.

7. *Angiosarcoma* takes origin from the outer coat of a blood-vessel. The growth is often very vascular, and when the blood-vessels are notably dilated the tumor is called a telangiectatic sarcoma. The ordinary forms of angiosarcoma are only moderately malignant, but alveolar and melanotic forms occur which are highly malignant. Angiosarcoma may arise in the skin, in a serous membrane, and in a salivary gland.

8. *Cylindroma, or Plexiform Sarcoma.*—In this variety the cells adjacent to vessels have undergone hyaline or myxomatous degeneration; the cells distant from vessels are unchanged. Section shows the normal cells apparently contained in spaces with hyaline walls. These degenerative changes occur most often in the angiosarcomata. Cylindromata arise from the brain, salivary glands, lachrymal glands, and rarely from the subcutaneous tissue. The growths are only moderately malignant.[1]

9. *Mixed tumors* consist partly of mature and partly of embryonic tissue, the cellular elements exceeding the adult elements in amount. Among these mixed tumors are fibrosarcoma or the recurrent fibroid tumor, myxosarcoma, chondrosarcoma, gliosarcoma, and osteosarcoma.

10. *Endotheliomata* are tumors springing from endothelium. In appearance an endothelioma strongly resembles cancer, and such a growth is often spoken of as endothelial cancer. It springs from endothelium, however, and is one of the connective-tissue tumors, and should be regarded as a sarcoma. Such growths can arise in many different situations, but are particularly common in the peritoneum, pleural membrane, membranes of the brain, ovary, and testicle. The proliferating endothelial cells lie in lymph-spaces, and the disease probably begins in the endothelium of these spaces. Endotheliomata grow rapidly and metastases are apt to pass to the serous membranes. In the brain and cord endothelioma may produce no symptoms for a long time. It is not possible, clinically, to distinctly recognize endotheliomata from ordinary sarcomata.

11. *Mycosis fungoïdes* is a disease which resembles sarcoma in many particulars and may be a form of sarcoma. It attacks the skin and subcutaneous tissues. The skin at

[1] Stengel: *Text-book of Pathology.*

first becomes red and swollen; numerous nodules form; the nodules become distinct tumors, soften at their centers, and fungation occurs. Microscopically the tumor resembles a lymphadenoma. Mycosis fungoïdes is considered by some pathologists to be multiple cutaneous sarcoma.

Treatment of Sarcomata.—Remove a sarcoma at once if it is in an accessible spot. Never delay removal. Cut well clear of it. If affecting a part where amputation is impossible, the rapidly growing sarcomata will almost inevitably return, and the very malignant variety, if uninterfered with, may terminate life in six months; but even in such case operation postpones the evil day and renders it possible that death will occur from metastatic growth in an organ, and that the patient will escape the horrors of ulceration and hemorrhage from the original tumor. Slowly growing and hard tumors offer some prospects of cure. The mixed tumor (as a recurrent fibroid) may repeatedly recur, and yet the patient may be cured at last by a sixth, an eighth, or a tenth operation. In sarcoma of a long bone amputation should, as a rule, be performed, though in some cases of giant-celled sarcoma of the radius, ulna, or fibula excision may be employed. In sarcoma of either jaw-bone, excision; of the eye, enucleation; and of the testicle, castration, is demanded. Sarcoma of the ovary in adults demands removal, but in children the operation is generally useless. Sarcoma of the kidney in adults calls for nephrectomy, but in children the operation is usually of little avail. In melanotic sarcoma remove the growth and adjacent lymph-glands, or in some cases amputate. Removal of a sarcoma when there is no hope of a cure is often justifiable to prolong life, to relieve the patient of a foul, offensive, bleeding mass, and to permit of an easier road to death by means of metastasis to an internal organ. In an inoperable case the ligation of the vessel of supply may do good. In sarcoma of the tonsil Dawbarn advises the extirpation of the external carotid artery and the ligation of its branches. The operation is performed first on one side of the tumor and in a week or so on the other side. I employed it in one case with distinct benefit. Wright advocates internal treatment for sarcoma and for cancer. He advises that bromid of arsenic be given for a long period of time, the dose being gr. $\frac{1}{10}$ to gr. $\frac{1}{40}$ after each meal. Before meals gr. x of carbonate of lime are advised. This treatment, Wright holds, should be used before, and for many months after, operation, as an aid to surgery. In inoperable cases it may be

tried.[1] Occasionally, though very rarely, suppuration cures a sarcoma. Wyeth, of New York, reported a case of sarcoma of the abdominal wall. It was found possible to remove only part of the growth; suppuration followed and the tumor disappeared, and ten years later had not returned.

It has been observed that an attack of erysipelas occasionally greatly benefits a sarcoma, causing large masses of the growth to soften or to slough and exposing a granulating surface. Busch noticed this in 1866, but the fact had been observed in the seventeenth century. Interest was decidedly awakened by Billroth's case of sarcoma of the pharynx which was cured by an attack of facial erysipelas. It was suggested that in inoperable cases of sarcoma erysipelas might be established artificially. Fehleisen inoculated tumors with cultures of erysipelas. Lassar, in 1891, employed the toxins (cultures rendered sterile by heat and filtration). In 1892 Coley began his observations. The first plan was as follows: a bouillon-culture is made of the streptococci; this culture is filtered through porcelain and an injection is given once a day into and about the sarcoma. The first dose is ♏x, and it is progressively increased; it should cause a febrile reaction, and sometimes establishes softening or suppuration. Coley's present method is as follows: make cultures of erysipelas cocci in cacao-broth; after three weeks inoculate them with the bacillus prodigiosus, and cultivate the mixed growth for four weeks. The mixed cultures are maintained at 136° F. until they become sterile. This sterile fluid contains the toxins. The dose is from 1 to 8 minims. The material is very powerful and may cause high fever. Begin with a small dose and gradually increase until the proper amount of reaction ensues (103°–104° F.). The injection may be about the sarcoma or at a distant point. It seems definitely proved that cases are occasionally cured by Coley's fluid. Spindle-celled sarcomata are influenced most favorably. Round-celled sarcomata are very refractory and so are cancers. The method is not entirely free from danger. Emmerich and Scholl claim good results from the injection of erysipelas serum. A sheep is injected with cultures of erysipelas, the blood is drawn, the serum separated, filtered to remove cocci, and injected about the sarcoma. Results are not definite. Among other agents which have been used to inject inoperable sarcomata we may mention alcohol, chlorid of zinc, arsenic, corrosive sublimate, thiosinnamin, pepsin, alkalies, etc. The injection of

[1] *Annals of Surgery*, April, 1893.

anilin-products into the sarcoma, which has received a qualified commendation from some observers, has been abandoned by most surgeons.

Innocent Epithelial Tumors.—These growths imitate an epithelial tissue of the mature and healthy organism.

Papillomata, or Warts.—Papillomata are formed upon the type of cutaneous and mucous papillæ. A papilloma consists of a fibrous stroma which contains blood-vessels and lymphatics and is covered with epithelium of the variety appertaining to the diseased part. Papillomata grow from the skin and from mucous membranes; they may be single or multiple; many may form in one region or various distant parts may be affected; they may be painless or may be ulcerated or bleeding; they vary in color from light pink to deep brown or black. Papillomata of the skin are usually hard; papillomata of mucous membranes are soft. A skin wart may be smooth and rounded, or may look like a cauliflower, the epidermis upon it being very rough. A papilloma of a mucous membrane looks like a cauliflower. Papillomatous masses may gather around the anus, the vagina, or the penis during the existence of a filthy discharge (venereal warts), and crops of warts may appear on the hands of those who work in irritant material (as petroleum). Papillomata are apt to arise in mucous membranes about carcinomata or chronic ulcerations. A large crop of warts may disappear in a single night; hence the popular belief in the efficacy of charms. Warts are particularly common on the skin of the back of the hands and fingers, the skin of the back, and the skin of the neck and scalp. A single skin-wart may reach the size of a walnut and become pigmented. The squamous epithelium covering a skin-wart may become horny (a wart-horn). Other cutaneous horns arise from the nails, from the scars of burns, or from ruptured sebaceous cysts.

Villous papillomata grow chiefly from the bladder, but they may also grow from the stomach and intestine. A papilloma of mucous membrane covered with squamous epithelium looks like a wart of the skin. Papillomata of the larynx are formed of squamous epithelium. Villous papillomata form tufts like the villous processes of the chorion; they may be single or multiple, and may be sessile or pedunculated; they are very vascular, and are apt to bleed freely. Papillomata may arise in cysts of the paroöphoron, in cysts of the mammary gland, from the choroid plexuses of the ventricles of the brain, and from the spinal membranes. Papillomata

may give rise to hemorrhage or may impair the function of a part. Any papilloma may become a cancer.

Treatment.—Venereal warts are treated by repeatedly washing with peroxid of hydrogen, drying with cotton, and dusting with a powder composed of borated talcum or of equal parts of calomel and subnitrate of bismuth, or of oxid of zinc and iodoform. If they do not soon dry up, cut them off with scissors and burn with the Paquelin cautery. Ordinary warts may usually be destroyed in a short time by daily applications of lactic or chromic acid. In multiple warts of the face Kaposi applies daily for several days a portion of the following combination: sublimed sulphur, ʒ5; glycerin, ʒ1½; acetic acid, ʒ2½. Keeping a wart constantly moist with castor oil will often cause it to drop off. Warts, and even extensive callosities, may be removed by painting once a day for five days with pure carbolic acid and covering with lint kept wet with boric acid. A convenient plan is to paint a wart daily with a solution containing 1 part of corrosive sublimate to 30 parts of collodion (hydrarg. chlor. corros., ʒ½; collodion, ʒ15). Large warts should be excised. Villous papillomata of the bladder demand the performance of a suprapubic cystotomy in order to remove them. A papilloma of the larynx may be removed with the cautery loop or may be destroyed with the cautery.

Adenomata.—Adenomata are tumors corresponding in structure to normal epithelial glands. They have a framework of vascular connective tissue, and they may contain acini and ducts like racemose glands or tubes like tubular glands. The acini or tubules contain epithelium of either the cylindrical or polyhedral variety. Adenomata grow from secreting glands, but cannot produce the secretion of the glands from which they spring; or, if they do secrete, the fluid is retained, and not discharged by the gland-ducts. Adenomata occur in the mammary gland, the parotid, the ovary, the thyroid gland, the liver, the sweat-glands, the sebaceous glands, the kidney, the pylorus, and the prostate; and they may spring as pedunculated growths from the mucous lining of the intestine and uterus. They are encapsuled, are usually single, but may be multiple, are of slow growth, but may attain a great size; they do not tend to recur after thorough removal, do not involve adjacent glands, and do not disseminate; they are firm to the touch; they tend to become cystic (especially in the thyroid), the fluid which distends the ducts being due to mucoid liquefaction of the proliferating epithelium. If cysts form, the growth is spoken of as a

cystic adenoma. If the framework of an adenoma contains considerable fibrous tissue, the tumor is named a fibro-adenoma. Adenomata are particularly liable to become carcinomatous.

In the breast a fibro-adenoma has a distinct capsule; it is elastic and movable, is usually superficial, and one occasionally exists in each gland. They are most common before the age of thirty, and are often painful, especially during menstruation. Cystic adenomata of the breast attain a large size; they are encapsuled and grow slowly, are most common after the thirtieth year, and are rarely painful. Both fibro-adenoma and cystic adenoma may arise in the male breast. Young unmarried women not unusually develop in the breast small, very tender, and painful bodies, most usually around the edge of the areola, which bodies increase in size and become more tender during menstruation; they are only cysts of the mammary tissue.

Adenomata of the thyroid gland begin before the fifteenth year. Adenomata may arise in the prostate if that gland be already the seat of senile hypertrophy. Adenomata of mucous glands may arise in the young or middle-aged. Adenomata of mucous membranes often cause hemorrhage and interfere with function.

Treatment.—Adenomata should be extirpated. To leave them alone exposes the patient to the danger of cancerous change. By confusing adenomata of the mammary gland with small cysts of that structure an erroneous belief has arisen that the former, as well as the latter, may sometimes be cured by the local use of iodin, mercury, ichthyol, and the internal use of iodid of potassium. The treatment in the breast, as elsewhere, is excision.

Malignant Epithelial Tumors, Carcinomata, or Cancers.—Cancers are tumors growing from epithelial surfaces, and are composed of embryonic epithelial cells which are clustered in spaces, nests, or alveoli of fibrous tissue and which proliferate enormously, extending beyond normal anatomical boundaries and as an invading host entering into connective tissues. The cells of a cluster are not separated by any stroma, and the walls of the alveoli carry blood-vessels and lymphatics. The growth may be cancerous from the start, or may have begun as an innocent epithelial tumor. Cancers are always derived from epithelium (of glands, of skin, of mucous membrane, etc.), and if found in a non-epithelial tissue must be secondary, or must have arisen from a dépôt of embryonal epithelial cells of prenatal

origin lying in the midst of a non-epithelial tissue. Carcinomata have no capsules, rapidly infiltrate surrounding tissues, and are firmly anchored and immovable. In the beginning a cancer is a local lesion; but it soon attacks related lymph-glands and by means of the lymph, and very rarely by the blood (Thiersch and Waldeyer), is disseminated throughout the system, secondary growths arising which are identical with the parent growth. Cancer is rare before the age of forty, and never occurs before puberty; and is sometimes linked with continued irritation as a cause (cancer of the penis in phimosis; cancer of the lip from the hot stem of a clay pipe; chimney-sweeps' cancer from soot in the scrotal folds; cancer of the gall-bladder when gall-stones exist). Dennis says that all clinical evidence points strongly to the view that inflammatory changes following irritation are responsible for cancer. Hereditary influence seems in some instances to favor the development of carcinoma. The weight of opinion is opposed to the theory that cancer is of parasitic origin. Tillmanns says that the presence of protozoa has never been proved.[1] The same author says that transplantation has taken place, but only by auto-infection or by transplantation to an animal of the same species. The facts that transplantation can be sometimes carried out, and that contagion is a possible occurrence under exceptional circumstances, do not prove that cancer is a parasitic disease, but simply prove that it can be transplanted. It is not that the cancer carries a parasite which will cause the disease in sound tissues, but rather that the cells of the cancer may themselves take root and grow in sound tissues (p. 266). A carcinoma is often the seat of pricking pain; the growth tends strongly to recur after removal; is prone to ulcerate, causing pain, hemorrhage, and cachexia; makes rapid progress, and is often fatal in from one to two and a half years. It is more common in women than in men, and rarely exists in association with tubercle. After a cancer has existed for a time in an important structure, or after a superficial cancer has ulcerated and become hemorrhagic, there are noted in the individual evidences of illness and exhaustion. We speak of this condition as the "cancerous cachexia," and in it the muscles are wasted, the body-weight is constantly diminishing, the complexion is sallow, the face is sunken, pearly white conjunctivæ contrast strongly with the yellow skin, the pulse is weak and rapid, and night-sweats add to the exhaustion. The above condi-

[1] *Verhandlungen der deutschen Gesellschaft für Chirurgie*, XXIV. Kongress, 1895.

tion is due to the absorption of toxic products from the diseased tissues, and also to pain, loss of sleep, bleeding, deprivation of exercise, malassimilation of food, and anxiety. Cancer may kill by obstructing a canal, by destroying the functions of a viscus or organ, by hemorrhage, by anemia, by sepsis, or by exhaustion. The death-rate from cancer increases year by year. It is pointed out by W. Roger Williams that in England and Wales the mortality from cancer has increased from 1 to 5646 in 1840 to 1 to 1306 in 1896, and the proportion to deaths from other causes has risen from 1 to 129 in 1840 to 1 to 22 in 1896.[1] The cause of this increase is doubtful, but the fact is alarming.

Classification of Carcinomata.—Carcinomata are classified as follows: 1. Epithelioma; 2. Rodent ulcer, or Jacob's ulcer; 3. Spheroidal-celled cancer (*a*, scirrhus; *b*, encephaloid; *c*, colloid); and 4. Cylindrical-celled cancer.

Epitheliomata.—An epithelioma arises from surface epithelium, and may arise from squamous cells or cylindrical cells, according to the location.

Squamous-celled epithelioma takes origin from the skin or from a mucous membrane covered with pavement-epithelium. It is especially apt to appear at the junctions of skin and mucous membrane (as the lips) or the point of juxtaposition of different kinds of epithelium. These growths arise in the anus, vagina, penis, scrotum, lips, tongue, mouth, nose, and other situations. There is an ingrowth of surface-epithelium into the subepithelial connective tissue, colonies of cells growing inward and forming epithelial nests. It may arise without discoverable cause, it may follow prolonged irritation, or it may arise in a wart or fissure. In the nipple it is not very unusually, and in the scrotum and nose it is occasionally, preceded by a persistent eczema, due possibly to psorosperms, and known as *Paget's disease.* Paget's disease is not a true eczema, but is rather a malignant dermatitis. A crust gathers on the part, and beneath this crust is a raw, red, and moist surface, the edge of which is slightly elevated and somewhat indurated. In the beginning there is a strong resemblance to eczema. The nipple is apt to retract. The parts are the seat of a constant itching and scalding sensation. The area may become cancerous in a few weeks, but may not for years. Squamous epithelioma generally begins as a warty proturberance which soon ulcerates. The malignant ulcer has a hard, irregular base, uneven edges, a foul, fungous-like bottom, and gives off a

[1] *Lancet*, Aug. 20, 1898.

sanious or ichorous discharge. This ulcer is the seat of sharp, pricking pain, sometimes bleeds, and extends over a considerable area, embracing and destroying every structure. Epithelioma affects lymphatic glands usually early, but such infection may be delayed for eight or ten months. Epitheliomatous glands break down in ulceration, making frightful gaps and often causing fatal hemorrhage. Dissemination is not nearly so common as in other forms of cancer, but it does sometimes occur.

Cylindrical-celled Epithelioma.—This form of growth takes origin from structures covered with or containing cylindrical epithelium, and it contains cylindrical or columnar cells. It is composed of a stroma of fibers between which lie tubular glands lined with columnar epithelium and containing masses of epithelial cells. Such tumors are found in the uterus and gastro-intestinal tract, and may begin from the surface epithelium or from the cells of tubular glands. In these tumors there is an acinus-like structure and the spaces are filled with proliferating epithelium. Cylindrical-celled cancers also arise from the mammary gland, liver, and kidney. One of the most common seats of cylindrical cancer is the rectum. Cancer of the rectum may occur at an earlier age than cancer elsewhere, being not uncommon between the ages of twenty-eight and forty. Cylindrical-celled epitheliomata are at first covered with mucous membrane, but they soon ulcerate and involve the submucous and muscular coats in the growth. They grow rather slowly, usually but not always cause lymphatic involvement, and finally disseminate widely. They require often from five to six years to cause death.

A *rodent* or *Jacob's* ulcer is scarcely ever met with except upon the face, though Jonathan Hutchinson saw one upon the forearm, and James Berry met with one upon the arm. It is especially common upon the nose and forehead. It begins after the age of forty as a little warty prominence which ulcerates in the center, the ulceration progressing at a rate equal to the new growth. The ulcer becomes deep; it is not crusted; its edges are irregular, hard, and everted; the floor is smooth and of a grayish color; the discharge is thin and acrid; and the parts about the sore contain numbers of visible vessels. Jacob's ulcer grows slowly, may last for years, does not involve the lymphatics, produces no constitutional cachexia, and is rarely fatal. A rodent ulcer is usually considered to be a malignant epithelial growth which springs from a sweat-gland, a sebaceous gland, or a hair-

follicle, but Kanthack asserts that before ulceration the rete and the sweat-glands are normal, but the sebaceous glands are destroyed. The base and edges of the ulcer are hard, which differentiates it from lupus; and, further, the bacilli of tubercle may sometimes be cultivated from the discharge of an area of lupus (p. 194). Rodent ulcer begins below the skin, ordinary epithelioma begins in the skin (Butlin), and a rodent ulcer contains no cell-nests.

Glandular Carcinoma.—Glandular carcinomata in structure resemble racemose glands. They consist of a stroma of connective tissue and alveoli filled with proliferating epithelial cells. If the proportion between the fibrous stroma and the cellular elements is about the same as in a normal gland, the growth is called simple. When the cellular element is in excess the growth is soft (medullary), and when the fibrous stroma is in excess the growth is hard (scirrhus).

1. *Scirrhous carcinoma* is a white and fibrous mass which has no capsule, which infiltrates tissues, and which draws in toward it, by the contraction of its outlying fibrous processes, adjacent soft parts, thus producing dimpling, or, as in the breast, retraction of the nipple. It is composed of spheroidal cells in alveoli formed of connective-tissue bands. The commonest seat of scirrhus is the female breast. It occurs also in the skin, vagina, rectum, prostate, uterus, stomach, and esophagus. It is most frequent in women after forty. It begins as a hard lump which is at first painless, but which after a time becomes the seat of an acute, localized, pricking pain. This lump grows and becomes irregular and adherent, causing puckering of the soft parts. After the skin or mucous membrane above it has become infiltrated ulceration takes place and a fungous mass protrudes which bleeds and suppurates. The adjacent lymphatic glands usually become cancerous, the time occupied being from six to ten weeks, and constitutional involvement is rapid and certain.

2. *Medullary* or *encephaloid carcinoma* is a soft gray or brain-like mass. It is a rare growth, it has no capsule, and it may appear in the kidney, liver, ovary, testicle, mammary gland, stomach, bladder, and maxillary antrum. An encephaloid cancer often contains cavities filled with blood, and this variety is known as a "hematoid" or a "telangiectatic" carcinoma. These growths are soft and semi-fluctuating, they infiltrate rapidly and soon fungate, and they terminate life in from a year to a year and a half. If the

cells of encephaloid become filled with melanin, the condition is called "melanosis" or "melanotic cancer."

3. *Colloid* cancer is extremely rare. It arises from either a scirrhus or encephaloid, when the cells or the stroma of such a growth undergo colloid degeneration. On section there will be seen in the center of the growth a series of cavities filled with a material resembling honey or jelly; the periphery is frequently an ordinary scirrhus or encephaloid cancer. Colloid degeneration is most prone to attack carcinomata of the stomach, mammary gland, and intestine. The name colloid cancer is often given to glistening, gelatinous, malignant growths springing from the ovary, testicle, mammary gland, or gastro-intestinal tract. The condition is due to mucous degeneration of the connective tissue or of the epithelial tissue of a carcinoma. Only a portion of the tumor may degenerate or the entire mass may become gelatinous.

Syncytioma Malignum.—By this name is meant a malignant epithelial growth arising from the site of the placenta during pregnancy or the puerperal state. It resembles placenta in appearance and rapidly causes metastases by way of the blood-vessels. It is quickly fatal.

Treatment.—Carcinomata demand early and free excision, with removal of implicated glands. Anatomically related lymph-nodes must be removed even if they show no evidence of involvement. If operation is early and thorough, and if certain regions are involved, a considerable proportion of cases can be cured. Carcinomata of the lip, the skin, and the mammary gland can often be cured. A recurrent growth may be removed as a palliative measure, to lessen pain and to relieve the patient from ulceration and hemorrhage, but such an operation is rarely curative. If a growth does not recur within five years after removal, a cure has probably been attained; in fact, if there is no recurrence within three years, the case is probably cured. The three-year limit has been usually accepted since Volkmann's paper on the subject. A rodent ulcer should be excised or else be curetted and cauterized with the hot iron or the Paquelin cautery. In cancer of the lower *lip*, remove the growth by the incision shown on page 747, or by a V-shaped incision, or cut away the entire lip. In every case remove the glands beneath the jaw. In cancer of the *tongue*, excise this organ and also the lymph-nodes from beneath the jaw and in the anterior carotid triangles. In cancer of the *breast*, remove the breast, the pectoral fascia, and the great pectoral muscle, and take away the fat and glands of the axilla. In cancer of the

rectum, if near the surface, excise the rectum from below; if above five inches from the anus, do the sacral resection of Kraske and then remove the growth. In cancer of the *esophagus*, perform gastrostomy; in cancer of the *pylorus*, perform pylorectomy or gastro-enterostomy; in cancer of the *bowel*, do resection with end-to-end approximation, side-track the diseased area by an anastomosis, or make an artificial anus; in cancer of the *penis*, amputate and remove the glands of the groin. Erysipelas toxins and erysipelas serum have been tried in inoperable carcinoma, but without any positive benefit. The same is true of pyoktanin, thiosinnamin, and of all other drugs that have been suggested. In some cases ligation of the artery of supply or extirpation of the artery, as suggested by Dawbarn, retards growth. In cancer of the breast, oöphectomy occasionally produces benefit or even cure (Beatson's operation). In inoperable cases palliative operations may be justifiable to relieve some urgent discomfort or get rid of a foul or bleeding mass. Gastro-enterostomy, gastrostomy, and colostomy are palliative operations. In a malignant growth of the nasopharynx tracheotomy may be required, and in a malignant growth of the neck of the bladder it may be advisable to perform suprapubic cystotomy. In an inoperable case relieve the pain by opium, giving as much as may be required to secure ease. Opium so used seems not only to relieve pain, but to retard the growth of the tumor and to favor the development of fibrous tissue in the stroma.

Cysts.—A cyst is a sac containing a fluid or a semi-fluid.

Division of Cysts.—Cysts are divided into (1) *Retention-cysts*, which are due to blocking up of the excretory ducts of glands and accumulation of the glandular secretions. These comprise sebaceous cysts or wens, serous cysts, mucous cysts, salivary cysts, milk-cysts, oil-cysts, and seminal cysts. (2) *Exudation-cysts*, which are due to accumulations in closed cavities. In this group are placed synovial cysts (ganglions and bursæ). Dentigerous cysts used to be considered under this head. (3) *Dermoid cysts*, which are congenital and arise from inversion of a portion of the epiblast and imperfect closure of fetal clefts. (4) *Cystomas*, which are cysts of new formation due to cystic degeneration of connective tissue. These cysts are found in the neck (hygroma), in the arm-pit, and in the perineum. An example of a cystoma is found in the bursa which develops from pressure. (5) *Extravasation-cysts*, that form around blood-extravasations. (6) *Hydatid cysts*, or cysts due to the echinococcus.

A mother-cyst is formed, which becomes filled with daughter-cysts floating in a saline liquor containing hooklets.

Sebaceous cysts arise when the excretory duct of a sebaceous gland is blocked by dirt or occluded by inflammation. The orifice of the duct is often visible as a black speck over the center of the cyst. They are very common in the scalp, being known as "wens," and upon the face, neck, shoulders, and back. Arising in the skin, and not under it, the skin cannot be freely moved over a sebaceous cyst. A sebaceous cyst is lined with epithelium and is filled with foul-smelling sebaceous material. A sebaceous cyst may suppurate. When a cyst ruptures and the contents become hard, a horn is formed. The other form of horn has been previously alluded to as due to horny transformation of a wart.

Treatment.—To treat a sebaceous cyst, incise the portion of skin above it, and dissect the sac entirely away with scissors or a dissector, trying not to rupture the delicate wall. If even a small particle of the wall is left, the cyst will reform. If it ruptures during removal and it is feared that some portion may remain, paint the interior of the wound with pure carbolic acid. If acid is not used, close without drainage; but if acid is used, drain for twenty-four hours. If an abscess forms in a sebaceous cyst, open it, grasp the edges of the cyst-lining with forceps, dissect out this lining with scissors curved on the flat, cauterize with pure carbolic acid, and drain for twenty-four hours.

Dermoid cysts are lined with true skin. They contain sebaceous matter, hair, teeth, or other epiblastic products. They are always congenital, but may be so small at birth as to escape notice for years. They may be distinguished from sebaceous cysts by the fact that they always lie below the deep fascia, and hence the skin is freely movable over them. They are met with at the root of the nose, at the orbital angles, in the eyelids, upon the floor of the mouth, over the sacrum or coccyx, and in the ovaries, the testicle, the brain, the eyes, the mediastinum, the lungs, the omentum, the mesentery, and the carotid sheaths. They are due to imperfect closure of fetal clefts and inclusion of epiblast. If a dermoid cyst contains bones, it shows that mesoblast was included as well as epiblast.

Treatment.—To treat a dermoid cyst, extirpate, if accessible, in the same manner as is recommended in the case of a sebaceous cyst. If it lies over bone, carry the incision down to the bone: the growth will be found adherent, so remove a portion of periosteum with the cyst.

Hydatid cysts are especially common in Iceland, and are frequent in Australia and South America, but are very rare in the United States. They are due to echinococci. The adult echinococcus is the tapeworm of the dog (tænia echinococcus), and its ova or larvæ gain access to man's body by accompanying the food he eats and passing into the alimentary canal, from which situation they are transported to various organs by the blood. Osler says the embryo (which has six hooklets) burrows through the wall of the bowel and enters the peritoneal cavity or muscles; it may enter the portal vessels and reach the liver, or may enter the systemic circulation and pass to distant parts. The danger depends on two factors: "the situation and the liability of the cyst to suppurate" (Sidney Coupland). The organs most usually attacked are the liver and lung. In 60 per cent. of cases the liver suffers, and in 12 per cent. the lung (Thomas). Cysts sometimes arise in the intestine, genito-urinary passages, brain, or spinal canal. When the embryo lodges the hooklets disappear and the embryo is converted into a cyst. This cyst is composed of two layers, an outer capsule (cuticular membrane) and an inner layer (endocyst). The cyst contains clear fluid. As the cyst grows, daughter-cysts bud out from the wall of the mother-cysts, the structure of the daughter-cysts being identical with that of the mother-cyst. From the lining membrane of all the cysts, after a time, growths arise known as scolices, which represent the head of the echinococcus and exhibit four sucking disks and a row of hooklets (Osler).

The fluid is not albuminous, is occasionally saccharine, is thin and clear, and may contain scolices or hooklets.

A hydatid cyst may calcify, may rupture, or may suppurate. These cysts are very firm, but usually fluctuate. Palpation with one hand while percussion is practised with the other gives a persistent tremor (hydatid fremitus). If the cyst can be safely reached, some fluid should be drawn and examined for diagnostic purposes. When a cyst suppurates positive constitutional and local symptoms arise. Hydatid cysts of the brain and cord tend to produce death in the same manner as do tumors. In the liver a cyst may rupture into the pleural sac, into the belly cavity, into the stomach or bowel, producing shock, hemorrhage, and probably death. In rare cases hydatid cysts rupture into the pericardium or into a great abdominal blood-vessel, or externally. Rupture into the bile-passages is usually followed by suppuration of the cyst. Suppuration of a cyst may follow uncleanly tapping.

Treatment.—An unruptured hydatid cyst of a superficial structure should be incised and the sac-wall should be dissected out. Hydatids of the brain have been successfully removed in Australia. A cyst of the kidney is removed through a lumbar incision. Omental cysts should be radically removed if possible; if this is not possible, open the abdomen, surround with gauze, evacuate through a trocar, stitch the cyst to the wound, incise, irrigate, and drain with gauze. Bond advocated evacuating the cyst, closing it with sutures, and dropping it back in the abdomen. Gardner says tapping is dangerous, as it may cause rupture of the cyst. In a hydatid of the liver the abdomen should be opened, the cyst should be surrounded with gauze pads, and tapped with a trocar and cannula. When the cyst is emptied of fluid it is grasped with forceps and pulled to the incision in the abdominal wall, it is sutured to this incision, the trocar-opening is enlarged, and the endocyst is removed by irrigation.[1] This operation is called marsupialization. If the cyst is on the summit of the liver, it may be reached by a transpleural hepatotomy. If aspiration is performed to settle a diagnosis, operate at once after doing it, because of fear that the cyst may leak and disseminate the disease throughout the peritoneal cavity. If hydatid fluid is disseminated throughout the peritoneal cavity, it may or may not lead to the development of new cysts, but it is almost certain to cause a febrile condition known as hydatid toxemia.

XVIII. DISEASES AND INJURIES OF THE HEART AND VESSELS.

Heart and Pericardium.—In an acute pulmonary congestion the venous side of the heart is over-distended with blood, and the surgeon in desperate cases may tap the right auricle (see Paracentesis Auriculi). Pericardial effusion, if severe, calls for tapping or aspiration, and purulent pericarditis demands incision and drainage.

Wounds and Injuries.—The heart may rupture and cause instant death, severe wounds usually though not always produce death, but slight wounds may not prove fatal. It is a popular impression that the expression "shot in the heart" or "stabbed to the heart" is another way of saying that instant death has occurred. This view was overthrown by experiments performed upon animals by Del Vechio and Philoppoo and by Block. These observers showed that pericardial

[1] John O'Conor, of Buenos Ayres, in *Annals of Surgery*, May, 1897.

and cardiac wounds are not of necessity instantly fatal, and that in some cases they can be successfully sutured. Several times during post-mortem examinations on human beings healed scars have been found upon the heart. The heart has been punctured a number of times accidentally or intentionally, and death has not ensued. John B. Roberts[1] of Philadelphia suggested in 1881 that it would be proper to try to suture wounds of the heart. A wound of the heart causes hemorrhage, usually copious; but owing to the interlocking of muscular fibers the hemorrhage is often slight. Bleeding may take place into the pericardial sac in some cases where the pericardium has been injured and the heart has escaped. Such an injury is occasionally inflicted by the sharp end of a fractured rib. The wound is rarely at or near the apex of the sac. In some cases the pleural cavity is opened and severe hemothorax occurs. The lung may or may not be injured. A wound of the pericardium or heart causes profound shock, irregular or very weak pulse, sighing respiration, dyspnea, and, it may be, the signs of hemopericardium or hemothorax. There may or may not be serious external bleeding. Fatal concealed hemorrhage may occur. Pain is constant, and attacks of syncope are the rule. Death is apt to occur suddenly from shock, hemorrhage, and inability of the heart to contract because of the severed fibers, or inability of the heart to dilate because of the pressure of blood in the pericardial sac. If a wound of the pericardium or heart does not cause death in the first day or two, inflammation follows (traumatic pericarditis or carditis).

Treatment.—Wounds of the pericardium and heart should be sutured, and every effort should be made to antagonize shock during the operation. The patient should be wrapped in hot blankets and surrounded with hot bottles or hot water-bags, or should be placed upon a table composed of pipes in which hot water circulates. The foot of the bed should be raised. Hot saline fluid should be infused into a vein. The extremities, except the one selected to infuse salt solution in, should be bandaged (auto-transfusion), an enema of hot coffee and whiskey should be given, and strychnin or atropin should be given hypodermatically. It is rarely proper to give an anesthetic. The heart is exposed by resecting several ribs, and usually the pleural sac is opened. Parrozzani makes a trap-door in the chest, the hinges of the door being the rib-cartilages. The heart is exposed, clots are removed from the pericardial sac, and the sac is irrigated with hot saline fluid.

[1] The author, in *Progressive Medicine*, vol. i., 1899.

A wound in the heart is sutured with silk, which is passed by means of a round, curved needle, and if a cavity of the heart is open, the suture includes the whole thickness of the heart-wall except the endocardium. The pericardium is sutured with silk, or, as was done in one successful case, the sac is packed with iodoform gauze (Rehn's case). It is not absolutely necessary to drain the pericardial sac. Clots are removed from the pleural sac by irrigation with hot saline solution, pulmonary bleeding is arrested by the suture or by packing, and a wound in the lung, especially if it communicates with the air-passages, should be sutured if the patient's condition justifies prolonging the operation.[1]

After such an operation the patient is in great danger, and every effort should be made to save him from shock. In performing operations upon the heart the pleura may be opened by design or by accident. When the pleura is opened there is always danger of pneumothorax, pulmonary collapse, and overwhelming shock. It is always well in such cases to have at hand the Fell-O'Dwyer apparatus, which will prevent or amend pulmonary collapse.

Dalton has sutured the pericardium. Rehn sutured a wound of the heart and packed the pericardium with gauze, and the patient recovered. Parrozzani successfully sutured a wound of the ventricle. Williams reports recovery after a stab-wound of the heart, the pericardium having been sutured. Fareni sutured a stab-wound of the left ventricle, and the patient lived several days. Cappelan sutured a wound of the heart, and the patient lived two and one-half days. Traumatic carditis or pericarditis is treated in the same way as idiopathic cases. Pus in the pericardial sac should be evacuated by resection of the fourth left costal cartilage and incision of the pericardium (von Eiselberg's case).

Phlebitis, or Inflammation of a Vein.—Phlebitis may be *plastic*, or it may be *infective*. Plastic phlebitis, while occasionally due to gout, to a febrile malady, or to some other constitutional condition, usually takes its origin from a wound or other injury, from the extension to the vein of a perivascular inflammation, or in the portal region from an embolus. Varicose veins are particularly liable to phlebitis. When phlebitis begins a thrombus forms because of the destruction of the endothelial coat of the vessel, and this clot may give rise to emboli, may be absorbed, or may be organized. Infective phlebitis is a suppurative inflammation of a vein, arising by infection from suppurating perivascular

[1] The author, on "Suture of the Heart," in *Progressive Medicine*, vol. i., 1899.

tissues (infective thrombophlebitis). It is not unusually met with in cellulitis or phlegmonous erysipelas, may arise in the lateral sinus as a result of mastoid suppuration, or in the liver from appendicitis or phlebitis of the rectal veins. A thrombus forms, the vein-wall suppurates, is softened and in part destroyed, and the infected clot softens and gives rise to emboli. No bleeding occurs when the vein ruptures, as a barrier of clot keeps back the blood-stream. The clot of suppurative phlebitis cannot be absorbed and cannot organize. Septic phlebitis causes pyemia, and the infected clots of pyemia cause phlebitis at the points of lodgement.

Symptoms.—The symptoms of plastic phlebitis are pain, tenderness in and around a vein, discoloration over it, and edema below the seat of the disease. Suppurative phlebitis, besides these conditions, causes the constitutional symptoms of pyemia (p. 178).

Treatment.—The treatment of plastic phlebitis comprises rest in bed, bandaging and elevation of the part, and the local use of ichthyol. Hot fomentations are used later in the case. The danger is embolism; hence massage and both active and passive movement are dangerous. When a vein is involved in a suppurative process and septic thrombophlebitis exists, ligate the vein, if possible, above and below the clot, open the vessel, and wash out the infected clot. This plan of treatment is always to be applied in infective thrombophlebitis of the lateral sinus and of the internal saphenous vein. The constitutional treatment is that of pyemia.

Varicose Veins; Phlebectasis, Phlebectasia, or Varix.—**Definition and Causes.**—Varicose veins are unnatural, irregular, and permanently dilated veins which are elongated and pursue a tortuous course. This condition is very common, and 20 per cent. of adults exhibit it in some degree in one region or another. The causes of varicose veins are obstruction to venous return and weakness of cardiac action, which lessens the propulsion of the bloodstream.

Varicose veins may occur in any portion of the body, but are chiefly met with on the inner side of the lower extremity, in the spermatic cord, and in the rectum. Varix in the leg is met with during and after pregnancy and in persons who stand upon their feet for long periods. It is especially common in the long saphenous vein, which, being subcutaneous, has no muscular aid in supporting the blood-column and in urging it on. The deep as well as the superficial veins may become

varicose. Verneuil maintained that varix of the superficial veins is almost always secondary to varix of the deep veins, a radical view which seems improbable. It is certain, however, that after contusions of the leg it is not unusual for the deep veins to become filled with clot and for the superficial veins to dilate notably. By the term "caput medusæ" is meant dilated veins radiating from the umbilicus. The veins of the esophagus may become varicose, and this malady is commonly unrecognized clinically. Varicose veins are in rare instances congenital; but they are most often seen in the aged, and usually begin between the ages of twenty and forty. They are more common in women than in men because of the influence of pregnancy.

Varix of the spermatic cord is known as "varicocele." It is apt to appear about the time of puberty, and most adult men have at least a slight varicocele. Varix is more likely to appear in the left spermatic vein than in the vein of the right side, because the left spermatic vein has no valves (Brinton).

Varix of the veins of the rectum is known as "hemorrhoids" or "piles." Piles are caused by obstruction to the upward flow in the hemorrhoidal veins, either by obstructive liver disease, enlargement of the uterus or prostate, or the presence in the rectum of fecal masses in a person habitually constipated.

A vein under pressure usually dilates more at one spot than at another, the distention being greatest back of a valve or near the mouth of a tributary. The valves become incompetent and the dilatation becomes still greater. Callender has pointed out that varix is apt to begin where the deep vessels join the superficial veins. At this point Treves says three forces meet, the blood-column above, the valve below, and the force of the blood-current. At this point the vein-wall dilates, and from this dilatation the blood-current is deflected and causes another dilatation higher up and on the opposite side of the vessel. The blood is again deflected and causes another dilatation, and so on (Agnew). The vein-wall may become fibrous, but usually it is thin and sometimes it ruptures. The veins not only dilate, but they also become longer, and hence do not remain straight, but twist and assume a characteristic form. Varicose veins are apt to cause edema, and the watery elements in the tissues cause eczema of the skin. When eczema is once inaugurated excoriation is to be expected. Infection of an excoriated area produces inflammation, suppuration, and an ulcer.

Delbet[1] points out that varicose veins of the leg, which began in the thigh, result from valvular incompetence, and ulcers arise from variations of pressure due to valvular incompetence. This incompetence of the valves does harm by allowing the intravenous pressure to equal the pressure in the arterioles, a condition which arrests capillary circulation and causes congestion, and greatly lowers tissue-resistance. Incompetent valves also favor ulceration by developing a vicious venous circle first described by Trendelenburg. Blood passing through this circle loses nutritive elements. Trendelenburg has described the vicious circle as follows: Blood in the saphenous vein flows toward the periphery instead of toward the center, it passes into the veins which connect the superficial veins with the deep veins and then enters the tibial and peroneal veins. It passes from the tibial and peroneal into the popliteal and femoral veins, and some of it leaves the femoral vein and again enters the saphenous.

The skin over varicose veins in the leg is often discolored by pigmentation due to the red blood-cells having escaped from the vessel and broken up. The tissues around a varicose vein become atrophied from pressure, and it is not unusual to meet with a very large vein whose thin walls are in close contact with skin. In this condition rupture and hemorrhage are probable. When the vein-wall forms a pouch-like dilatation the condition is spoken of as a cyst. Varicose veins are apt to inflame, and thrombosis frequently occurs. When a thrombus forms, especially if the patient walks about, emboli may be broken off and carried into the circulation, but embolic formation is not so common in thrombosis in a varicose vein as in thrombosis in an undistended and unelongated vessel.

Treatment.—The treatment of varix may be *palliative* or *curative*, but whichever plan is followed, the surgeon should endeavor first of all to remove the exciting cause. An essential part of palliative treatment is to attend to the general health, to keep up the force and activity of the circulation, and to prevent constipation. The patient should exercise in the open air and should lie down for a time, if possible, every afternoon. Locally, in varix of the leg, use a flannel roller or a Martin rubber bandage to support the veins and drive the blood into the deeper vessels which have muscular support. The use of a rubber pad filled with glycerin and applied over the saphenous vein so as to support the

[1] *Sem. méd.*, October 13, 1897.

blood-column and act as a valve, has been recommended. Locally, in varicocele, pour cold water upon the scrotum twice a day and order the patient to wear a suspensory bandage. Locally, in hemorrhoids, use injections of ice-water and astringent suppositories. A purely local varix should be excised, because there is always danger of injury, and consequently of hemorrhage or thrombosis. If the superficial veins have dilated because of thrombosis of the deep veins and edema exists, operation is contraindicated, as its performance might lead to permanent edema. If the disease involves the leg only, operative treatment is rarely required, and may even do harm. Such cases are operated upon if there are cyst-like dilatations; if thrombi form and, as Bennett points out, if a thin-walled vein crosses the tibia, and is thus exposed to the danger of injury and thrombosis.[1]

If the leg is involved in the process, and the saphena in the thigh is also varicose, operation should be performed.

If a thrombus forms in a varicose vein, tie the vein above and below the clot, divide the vessel in two places, and remove the vein and the clot within it. Thrombus in a varicose vein is not so apt to lead to emboli as thrombus in a non-varicose vein, but it may do so, and the condition is dangerous.

The radical treatment of varix of the leg often does good, often relieves some annoying condition, but rarely absolutely cures (W. H. Bennett). There are several methods of operation: ligation with excision of part of the vein, exposure and ligation of the vein below the saphenous opening, circular incision around the leg (see Operations upon Vessels).

Nevus.—(See Tumors.)

Arteritis, or inflammation of an artery, is *acute* or *chronic.*

Acute arteritis may result from injury or from extension of inflammation from the perivascular tissues (aseptic or productive arteritis). Arteries are very resistant to the spread of inflammation, but we sometimes meet with suppurative arteritis in suppurating areas. In acute suppurative arteritis the coats ulcerate through, but hemorrhage rarely occurs unless a considerable portion of the vessel sloughs. Septic emboli lodging in the arterial system produce acute septic arteritis. This is seen during the progress of ulcerative endocarditis.

Chronic arteritis is due to increase of blood-pressure from hard work, strains, heart-disease, or contracted kidneys. It is especially common in drunkards, but it occurs also in

[1] W. H. Bennett, *Lancet*, October 15, 1898.

aged men who never drank. Chronic arteritis is most frequent in the larger arteries. It is a true saying of Cazalis that "A man is as old as his arteries," and a young man dilapidated by syphilitic disease or alcohol may have diseased arteries, and hence be really older than a healthy man of sixty. In chronic arteritis exudation of serum and migration of leukocytes take place beneath the intima, and a like exudation soon becomes manifest in the media, in the adventitia, and even in the sheath. The exudate may be absorbed, or connective tissue-cells may proliferate and fibrous tissue form (arterial sclerosis), or the mass of new cells may undergo fatty degeneration (atheroma). When fatty degeneration occurs the endothelium is destroyed, the vessel-wall is damaged, and the blood may obtain access to the deeper coats. Calcareous change may follow fatty degeneration.

An atheromatous artery is rigid and inelastic, and the parts it supplies are cold, congested, and ill-nourished. Atheroma is a frequent cause of thrombosis, aneurysm, senile gangrene, and apoplexy. Syphilitic arteritis is characterized by an enormous growth of granulation-tissue from the inner coats (obliterative endarteritis) of arteries of small size. Calcification of an artery may be secondary to fatty change, or may occur primarily from deposit of lime salts in the middle coat. Periarteritis is inflammation of the sheath and outer coat. An acute arteritis is always local, but a chronic arteritis may be general.

Treatment of acute arteritis consists of rest, elevation, and relaxation, and the application of ichthyol ointment. Hot fomentations are applied later. If abscesses form in a septic case, they must be opened and drained. Internally, treat any diathesis (rheumatic, gouty, or syphilitic), maintain kidney secretion, quiet the circulation, and employ a non-stimulating diet. The part must be kept quiet, as rough movement would tend to rupture the vessel.

Treatment of Chronic Arteritis.—In treating chronic arteritis, endeavor to antagonize the dangers to which the patient is obviously liable. Stop alcohol as a beverage, though a little whiskey may be taken at meals to aid digestion. Maintain the activity of the skin by daily baths, and of the kidneys by diuretic waters. A daily bowel movement should be secured. The diet is to be plain and is to contain a minimum of nitrogen. If syphilis has existed, occasional courses of iodid of potassium are to be given. If the arterial tension at any time becomes inordinately high, administer nitroglycerin. One danger to which the patient is

liable is apoplexy; hence excitement and violent exercise are to be avoided. Another danger is senile gangrene; hence the patient should wear woollen stockings, put a hot bottle to his feet at night, and be careful to avoid injuring his toes or feet, especially when cutting his corns. When a patient with atheroma has dyspnea and is of a livid color, or when the arterial tension is very high, a moderate blood-letting (sixteen to eighteen ounces) does good, and may prevent or arrest edema of the lungs. Still another danger is aneurysm, which may appear suddenly from rupture or gradually from progressive distention.

Aneurysm.—An aneurysm is a pulsating sac containing blood and communicating with the cavity of an artery. Some restrict the term "true aneurysm" to a condition of dilatation involving *all* the coats of the vessel. We shall consider, with Heath, a *true* aneurysm to be one in which the blood is included in one or more of the arterial coats, and a *false* aneurysm to be a condition in which the vessel has ruptured or has atrophied and the aneurysmal wall is formed by a condensation of the perivascular tissues.

Forms of Aneurysm.—The following forms of aneurysm are recognized:

1. *True aneurysm*—one whose sac is formed of one or more arterial coats.
2. *False aneurysm*—one whose sac is formed of condensed perivascular tissues and contains no arterial coat.
3. *Traumatic aneurysm*—a false aneurysm due to traumatic rupture some time before, the blood being in a sac of tissue and any wound being healed.
4. *Fusiform aneurysm*—a variety of true aneurysm, the sac being spindle-shaped.
5. *Consecutive aneurysm*—a sacculated aneurysm diffused by rupture, or a false aneurysm due to gradual destruction or atrophy of a true aneurysmal sac or to vascular rupture.
6. *Sacculated aneurysm*—a common form of aneurysm, in which the dilatation is like a pouch, arising from a part of the arterial circumference and joining the lumen of the vessel by an aperture.
7. *Dissectiug aneurysm* (Shekelton's aneurysm)—a pouch-like dilatation of an artery due to the blood which has gained access to the middle coat through an atheromatous ulcer or a minute rupture of the inner coat. It used to be taught that the blood flows between the media and adventitia; we now know that it flows between the layers of the middle coat. The outer wall of the aneurysm consists of adventitia

and a portion of the middle coat. It may or may not join the lumen of the artery at another point by a fresh aperture in the intima. Dissecting aneurysm is practically only met with in the aorta. It is most common in the thoracic aorta. About eighty cases have been reported.[1]

8. *Arteriovenous aneurysm*, which is divided into aneurysmal varix, or Pott's aneurysm, where there is direct communication between a vein and an artery; and varicose aneurysm, where there is communication between an artery and a vein by means of an interposed sac.

9. *Acute aneurysm*—a cavity in the walls of the heart, which cavity communicates with the interior of this organ, and which is due to suppuration in the course of acute endocarditis or myocarditis.

10. *Aneurysm by anastomosis* (see Angiomata).

11. *Aneurysm of bone*—an inaccurate clinical term used to designate a pulsatile tumor of bone.

12. *Circumscribed aneurysm*—when the blood is circumscribed by distinct walls.

13. *Cirsoid aneurysm*—a mass of dilated and elongated arteries shaped like varicose veins and pulsating with each heart-beat.

14. *Cylindrical aneurysm*—a dilatation which maintains the same dimensions for a considerable space.

15. *Embolic* or *capillary aneurysm*—dilatation of terminal arteries due to emboli.

16. *Spontaneous aneurysm*—non-traumatic in origin.

17. *Miliary aneurysm*—a minute dilatation of an arteriole.

18. *Secondary aneurysm*—one which, after apparent cure, again pulsates, the blood entering by means of the anastomotic circulation.

19. *Verminous aneurysm*—one containing a parasite. This form of aneurysm is met with in the mesenteric artery of the horse.

The sac of a sacculated aneurysm is at first composed of at least two of the arterial coats, reinforced by the sheath and perivascular tissues. After a time the blood-pressure distends the sac, and the inner and middle coats either stretch with interstitial growth or—what is more common—are worn away and lost. When all the coats are lost, and the blood is sustained only by the sheath and surrounding tissue, a true aneurysm becomes a false, diffuse, or consecutive aneurysm, the limiting tissues and sheath being condensed, thickened, and glued together. This limiting process is de-

[1] Coleman, in *Dublin Jour. Med. Sciences*, August, 1898.

ficient in the brain; hence cerebral aneurysms break soon after their formation. When all the arterial coats are lost, the blood-pressure, acting on the tissues, finds some spots less resistant than others, the blood follows the lines of least resistance, the aneurysm grows with great rapidity, and soon ruptures externally or into a cavity.

An aneurysm may rupture into a cavity (pleural, pericardial, or peritoneal), into the perivascular tissues, or through the skin. Rupture into the tissues may produce pressure-gangrene. When rupture occurs through the skin the hemorrhage is not often instantly fatal, but during several days constantly recurs in larger and larger amounts. The pressure of an aneurysmal sac causes atrophy of tissues, hard and soft, bones and cartilages being as easily destroyed as muscles and fat. Sometimes the perivascular tissues inflame and suppurate, and the sac is opened rapidly by sloughing. An aneurysm usually progresses toward rupture, the slowest in this progression being the fusiform dilatations, which may exist for many years, but which finally is converted into the sacculated variety.

In some rare instances there takes place spontaneous cure, which may result from laminated fibrin being deposited upon the walls of the sac as the blood circulates through it. This laminated fibrin is known as an "active clot," and eventually fills the sac. The weaker and slower the blood-stream, the greater is the tendency to the formation of an active clot; hence any agent impeding, but not abolishing, the circulation aids in the deposition. This weakening and slowing of circulation may be brought about by great activity of the collateral circulation deviating most of the blood away from the area of disease. Sometimes a clot breaks off from the sac-wall and plugs the artery beyond the aneurysm, and the anastomotic vessels, enlarging, divert the blood-stream. A large aneurysm, falling over by its own weight upon the vessel above the mouth of the sac, may, in very unusual cases, diminish the blood-stream. The development of another aneurysm upon the same vessel nearer to the heart weakens the circulation in and may cure the older one. Inflammation occasionally forms a clot. The tissues about an aneurysm tend to contract when arterial force is lessened; hence tissue-pressure may more than counteract blood-pressure when the circulation is feeble. Clotting of the blood contained within a sac, circulation through the aneurysm having ceased, causes a passive clot. A passive clot, which occasionally cures, may arise from a twisting of the neck of the sac, preventing the

passage of blood: from the lodgement of a clot in the mouth of the sac; and from inflammation. Spontaneous cure is, unfortunately, very rare.

Causes of Aneurysm.—Gradual distention of arterial coats which are in a condition of arterial sclerosis, or of coats whose resisting power is lowered because of atheroma, may cause aneurysm. Hence the causes of sclerosis and atheroma are also causes of aneurysm. The principal cause of aneurysm is increased blood-pressure. This increase may be brought about by severe labor; by sudden strains, as in lifting; by violent efforts, as in rowing in a boat-race; by chronic interstitial nephritis; by hypertrophy of the heart; by alcoholic inebriety; and by syphilis. Arterial disease is commonest in the larger vessels and in the aged, but it may occur in youth. When an aneurysm follows a strain, it may be due to laceration of the media and loss of resistance at a narrow point. The intima may lacerate, permitting the blood to come in contact with the media or causing blood to diffuse between the coats (dissecting aneurysm). When an embolus lodges in an artery the vessel may become aneurysmal on the proximal side of the clot. The embolus, if infective, causes softening, and if calcareous causes laceration (Osler). Colonies of micrococci may cause aneurysm.[1] The parasite *strongylus armatus* causes aneurysm of the mesenteric arteries in horses. Suppuration around a vessel weakens its coats and tends to aneurysm by inducing acute arteritis and softening. Sometimes an individual develops multiple aneurysms the origins of which are absolutely unknown.

The constituent parts of an aneurysm are (1) the wall of the sac; (2) the cavity; (3) the mouth; and (4) the contents.

Symptoms of Aneurysm.—An oval or globular, soft, elastic, and pulsatile protrusion, develops in the line of an artery. It is usually quite evident to the touch that the sac contains fluid, but sometimes in old aneurysms the sac feels firm or even hard, because of the deposit of fibrin upon its inner surface. In a partially consolidated aneurysm pulsation may be slight or even inappreciable. The protrusion instantly ceases to pulsate and almost disappears on making firm pressure on the artery above. On relaxing the pressure the pulsatile enlargement at once reappears. Direct pressure upon the tumor may cause it to almost disappear. Pressure upon the artery below causes the tumor to enlarge. The pulsation is expansile—that is, it expands in all direc-

[1] See Osler on *Malignant Endocarditis.*

tions—and if an index-finger be laid on each side of the tumor so that the points nearly touch, each pulsation not only lifts the fingers, but it also separates them. On placing a stethoscope over the aneurysm or over the vessel below the aneurysm there is imparted to the ear a distinct bruit which travels in the direction of the blood-stream, is systolic in time, and is usually blowing in character. In some cases bruit is absent (when a sacculated aneurysm has a very small mouth, when the circulation is tranquil, or when the sac is full of blood and clot). When bruit is absent it may sometimes be developed by muscular exercise or raising the affected limb (Holloway). In rare cases there may be a double bruit. Occasionally in fusiform aortic aneurysm linked with aortic regurgitation a diastolic bruit exists. A bruit is arrested by pressing upon the artery between the aneurysm and the heart.[1] The skin over an aneurysm may be normal or discolored, and may slough or ulcerate. Aneurysm of an extremity is apt to produce edema and varicose veins, because of pressure upon large veins and loss of vis a tergo in circulation. The muscles feel tired, and sometimes there is pain. In internal aneurysms pressure-symptoms are marked. Thoracic aneurysm causes intercostal pain; iliac aneurysm causes pain in the thigh. Aneurysm of the

1  2

Fig. 68.—Radial pulse-tracings in aneurysm of right brachial artery: 1, left radial pulse; 2, right radial pulse (after Mahomed).

thoracic aorta pressing upon the pneumogastric nerve causes spasmodic dyspnea, and upon the recurrent laryngeal, causes loss of voice and paralysis of all the muscles of the larynx except the cricothyroid. The pulse below an aneurysm is weaker than the pulse of the corresponding part of the opposite limb. This is well shown by the sphygmograph, the tracings being rounded without a sudden rise or an abrupt fall (Fig. 68). The evidences of rupture of an aneurysm of an extremity into the tissues are loss of distinctness of outline and increase in area of the tumor, weakening or disappearance of both bruit and pulsation, absence of

[1] Holloway on "Aneurysm," in Park's *Surgery by American Authors.*

pulse below the aneurysm, severe pain, edema and coldness of the surface, shock, and possibly syncope. External hemorrhage may arise; the tissues may become extensively infiltrated with blood; sloughing or gangrene may ensue. Death is frequent, and only in very rare cases does spontaneous cure take place. Rupture of a large aneurysm into a cavity causes intense pallor, advancing weakness, syncope, and death.

Diagnosis.—A cyst or abscess over a vessel may show transmitted pulsation which is not expansile, and the tumor does not disappear on pressure above it. The pulsation ceases when the growth is lifted off the vessel, or when the position is changed so as to permit it to fall away from the vessel. There is no true bruit, and the history is widely different. A growth under a vessel may lift the vessel and simulate an aneurysm, but the pulsation is not noted in the entire growth, the growth does not disappear on proximal pressure, and there is only a false, and never a true, bruit. The larger the growth the less is the pulsation, because of pressure upon the vessel. A sarcoma, especially a soft sarcoma attached to the bone, and also a nevoid mass, pulsate and often have a bruit; the tumor never disappears from proximal pressure, though it may slowly diminish in size, to gradually enlarge again when pressure is withdrawn. These growths do not feel fluid, and are rarely circumscribed. An aneurysm may cease to pulsate from consolidation leading to cure, or from rupture. Rupture of a large aneurysm into a cavity induces deadly pallor, syncope, and rapid death. Rupture of an aneurysm of an extremity into the tissues is made manifest by a sensation of something breaking, by pain, by sudden increase in size, by diminution or absence of bruit and pulsation, by absence of pulse below the aneurysm, by swelling and coldness of the limb, and by shock.

Treatment.—In inoperable aneurysms *general*, *medical*, and *dietetic* treatment must be tried. A chief element in treatment is rest in bed to diminish the rapidity and force of the circulation and favor fibrinous deposit. Tuffnell's plan is to reduce the heart-beats by rest and mental quiet, and to rigidly restrict the diet so as to diminish the total amount of blood and render it more fibrinous. Liquids are restricted in amount, and the patient lives each twenty-four hours upon four ounces of bread, a very little butter, eight ounces of milk, and three ounces of meat. Pursue this plan for several months if possible, or employ it for several weeks, intermit for a short period, return again to the rigid diet, and so

on, over and over again. There can be no doubt that Tuffnell's treatment sometimes cures aneurysm by decidedly lowering the blood-pressure. Valsalva long ago suggested rest, occasional bleeding, and a diet just above the point of starvation. In many cases of aneurysm the patient may be permitted to go about, taking his time about everything and avoiding work, worry, and excitement. The diet should be low and non-stimulating, and the bowels must be maintained in a loose condition.

Lancereaux and others claim that hypodermatic injections at some indifferent point of a 1 or 2 per cent. solution of gelatin in normal salt solution do good in aortic and innominate aneurysms. Lancereaux injects 250 c.c. of the solution into the subcutaneous tissue of the thigh every ten to fifteen days. From 10 to 20 injections may be given. The treatment is not free from danger (two deaths have occurred), is only to be used for sacculated aneurysms, and the gelatin solution is never to be injected into a vessel or about the sac. A 1 per cent. solution is safer than a 2 per cent. solution, and probably as efficient. Iodid of potassium in doses of 20 grains undoubtedly does good, and not only in syphilitic cases. It seems to lower the blood-pressure. Balfour taught that it thickened the walls of the sac. Osler says it relieves the pain. Iron, acetate of lead, and ergotin are prescribed by some. Digitalis is contraindicated, as it raises the blood-pressure. S. Solis Cohen has used with some success the hydrated chlorid of calcium. Morphin and bromid of potassium are occasionally useful to tranquillize the circulation, allay pain, or secure sleep. Aconite and veratrum viride have long been employed. Other expedients are: the kneading of the sac to release a clot, in the hope that it will plug the mouth of the sac or the artery beyond it—this is dangerous; electricity; electrolysis; the injection of an astringent liquid; the insertion of a fine aspirating-needle and the pushing through it into the sac of a large quantity of silver wire, in the hope that it will aid in whipping out fibrin. Some physicians have inserted needles and horse-hair.

Even in an operable case diet and rest are of importance. The patient should be in bed for a number of days before operation, the daily diet consisting of ten or twelve ounces of solid food with a pint of milk. If the circulation is very active, use aconite and allay pain by morphin.

Treatment by Pressure.—*Instrumental pressure* is made by applying two Signorini tourniquets or some specially devised

apparatus to limit the flow of blood through an aneurysm without entirely stopping it, the aneurysmal sac being felt to still slightly pulsate. In some situations Lister's abdominal tourniquet is applied; in other regions we may use Tuffnell's compress, which is like a spring truss and is strapped in place. A heavy body suspended over the artery and resting part of its weight upon the vessel has occasionally brought about cure. Compressing instruments can be worn for from twelve to sixteen hours at a time; usually they are removed to permit sleep and are reapplied the next day, and so on for several days. Before applying the compress be sure the sac is full of blood, and render this certain by applying for a few minutes distal compression. This method may cure, but it is very painful. It cannot be used successfully in treating aneurysm of the axillary, subclavian, or carotid artery. It aids in the formation of an active clot.

Digital pressure, made with the thumb aided by a weight, and maintained for many hours by a relay of assistants, has cured many cases. This method may be used alone or may be used as an accessory to instrumental pressure. Its chief field is in the treatment of aneurysm for which other methods are inapplicable (orbit and root of neck). It entirely cuts off the blood and promotes the formation of a passive clot. If cure does not take place in three days, abandon pressure. It must often be abandoned far earlier because of pain.

Direct pressure upon the sac has been used in aneurysm of the popliteal artery, the pressure being obtained by flexing the leg; and in aneurysm of the brachial artery pressure has been applied at the bend of the elbow by flexing the elbow. The pressure of a hollow rubber ball has been used in aneurysm of the subclavian.

Rapid pressure completely arrests the passage of blood through the sac for a limited time, and is applied while the patient is under the influence of an anesthetic. Take, for example, a case of popliteal aneurysm; the patient is placed under ether; two Esmarch bandages are used, one being put on the limb from the toes to the lower limit of the aneurysm, and the other from the groin down to the upper limit of the sac, and the Esmarch band is fastened above the upper bandage. This procedure stagnates the blood both in the veins and in the arteries, the sac remaining full of blood. Pressure is thus maintained for three or four hours, and on removing the Esmarch apparatus a tourniquet is put on the artery above the aneurysm and partly tightened to limit the amount of blood passing through and thus prevent

the washing away of clot. This method of rapid pressure sometimes cures by formng a passive clot, but it sometimes results in gangrene. It was devised by John Reid.

Operative Treatment: By the Ligature.—Ligation of the main artery is, as a rule, the best procedure. The methods of ligation are—(1) the method of Antyllus; (2) the method of Anel; (3) the method of Hunter; (4) the method of Wardrop; and (5) the method of Brasdor.

In the *method of Antyllus* (Fig. 69), the sac itself is attacked. The artery is ligated immediately above and below the sac, the sac is opened and its contents turned out, or the sac is extirpated. This method is of the greatest use for traumatic aneurysms. Syme suggested many years ago that extirpation was the proper operation for aneurysm of the gluteal, iliac, carotid, and axillary arteries. In some cases it is the best method. If the wall of the blood-vessel is diseased beyond the aneurysm, the above method should not be used, because it is not wise to apply ligatures to diseased areas of the vessel.

The Method of Anel.—In Anel's method the artery is ligated above the sac, and so close to it that there are no anastomatic branches between the sac and the ligature (Fig.

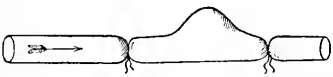


FIG. 69.—Old operation of Antyllus for aneurysm (*Am. Text-Book of Surgery*).

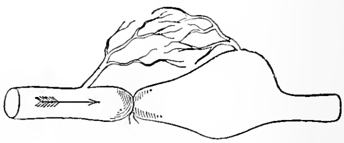


FIG. 70.—Anel's operation for aneurysm (*Am. Text-Book of Surgery*).

70). It is used only for traumatic aneurysms, and is never employed when the vessel is diseased beyond the aneurysm.

The Method of Hunter.—This operation, which is the modern method of ligation, was devised by the illustrious John Hunter. He recognized the fact that the vessel adjacent to an aneurysm was apt to be diseased, and he discovered the anastomotic circulation. Putting together these two facts he devised the operation which goes by his name. It consists in applying a ligature between the heart and the aneurysm, but so far above the sac that collateral branches are given off between it and the point of ligation (Fig. 71). This operation, which is done upon a healthy area, does not permanently cut off all blood, but so diminishes the force and frequency of the circulation that an active clot forms within

the sac. Thus is lessened the danger of secondary hemorrhage and of gangrene. It is, in the majority of cases, the proper operation for aneurysm. In some cases pulsation does not return after tightening the ligature; in most cases, however, it reappears for a time after about thirty-six hours, but is weak from the start, constantly diminishes, and finally disappears permanently. Previous prolonged compression by enlarging the collateral branches permits strong pulsation to soon recur after ligation, and thus militates against cure; hence it is a bad plan to use pressure in cases admitting of ligation, and in which the success of pressure is very doubtful. Occasionally after Hunter's operation the sac suppurates, producing symptoms like those of abscess. Sup-

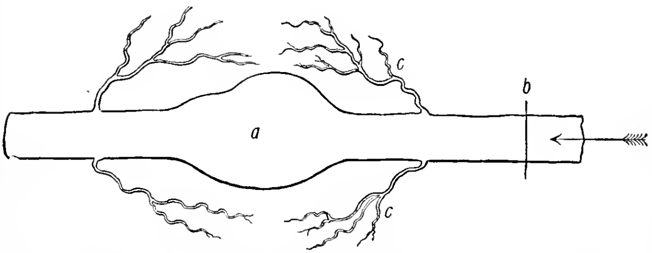


FIG. 71.—Hunter's method of ligating for aneurysm: *a*, the aneurysm; *b*, the point of ligation; *c*, the branches between the aneurysm and the ligature. The arrow shows the direction of the blood-current.

puration may occur between the first and thirty-second week after ligation.[1] When pus forms open freely as we would open an abscess, and, if no blood flows, treat as an abscess, but have a tourniquet loosely applied for several days ready to screw up at the first sign of danger. If hemorrhage occurs, tie the vessel above and below the aneurysm, open the sac, and pack with iodoform gauze. If bleeding recurs, there is no use reapplying the ligature and there is little use tying higher up. If dealing with an arm, try the application of a ligature higher up; if dealing with a leg, amputate at once.

Distal Ligation.—When an aneurysm is so near the trunk that Hunter's operation is impracticable, or when the artery on the cardiac side of the tumor is greatly diseased, distal ligation may be employed. Distal ligation forms a barrier to the onflow of blood, collateral branches above the aneurysm enlarge, the blood-current is gradually diverted, and a clot may form within the aneurysm. Distal ligation is

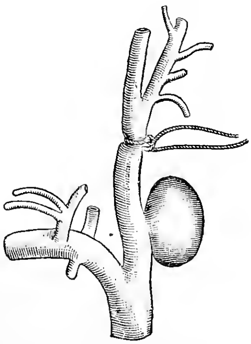
[1] See the case described by Sir Astley Cooper.

used in some aneurysms of the aorta, iliacs, innominate carotids, and subclavians. It occasionally causes rupture of the sac of the aneurysm.

The operation of Brasdor consists in tying the main trunk some little distance below the aneurysm (Fig. 72). It completely arrests circulation in the sac.

The operation of Wardrop consists in tying one of the branches of the artery below the aneurysm. Wardrop originally advocated ligation at a point where there was no intervening branch between the sac and the ligature. Later he advocated ligation when there was an intervening branch. Since then it is the custom to consider Wardrop's operation to be the ligation of one branch below the aneurysm, as shown in Fig. 73. The circulation is but partially arrested by Wardrop's operation. An X-ray picture should be taken in every case of aortic aneurysm. Such a picture may aid us in coming to a conclusion as to which vessel or vessels to tie.

After ligating for aneurysm by any of these methods, elevate the limb, keep it warm, and subdue arterial excite-



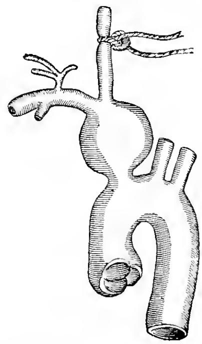


FIG. 72.—Brasdor's operation (Holmes). FIG. 73.—Wardrop's operation (Holmes).

ment. When gangrene of a limb follows ligation, await a line of demarcation, and when it forms amputate. Rupture of the sac after ligation may produce gangrene or be associated with suppuration, the first condition demanding amputation, and the second incision for drainage.

Injection of coagulating agents into the sac (ergot, perchlorid of iron, etc.) is very dangerous and is to be utterly condemned. It may lead to suppuration, gangrene, rupture, or embolism.

Manipulation to break up the clot was suggested by Sir

Wm. Fergusson, and has been practised. The object aimed at is to have a fragment of clot block up the vessel upon the peripheral side of the artery and act like a distal ligature. The method is dangerous and should never be employed.

Amputation, instead of distal ligation, is performed in some perilous cases of subclavian aneurysm.

Electrolysis.—An attempt may be made to coagulate the blood at once, or from time to time an endeavor may be made to produce fibrinous deposits, but the first method is the better. It is, however, rarely possible to at once occlude a sac, and pulsation, which is for a time abolished, recurs as the gas present is absorbed. Use the constant current. Take from three to six cells which stand in point of size between those used for the cautery and those used for ordinary medical purposes. A platinum needle is attached to the positive pole and a steel needle to the negative pole, each needle being insulated by vulcanite at the spot where the tissues will touch it. The asepticized needles are plunged into the sac where it is thick, and they are kept near together. The current is passed for a variable period (from half an hour to an hour and a half). This operation is not dangerous. Pressure stops the bleeding. Electrolysis often ameliorates, and sometimes, though very rarely, cures, aortic aneurysms.[1]

Acupressure consists of the partial introduction of a number of ordinary sewing-needles into an aneurysmal sac and leaving them in it for five or six days or more. Prof. Macewen introduces a needle, and with it irritates the interior of the sac of an aneurysm, hoping thus to cause deposition of leukocytes and clot-formation.

Introduction of Wire.—Insert into the sac a hypodermatic or small aspirating-needle, and push through the needle or cannula a considerable quantity of aseptic gold wire, which is allowed to remain permanently. Electrolysis should be combined with the introduction of wire. This operation was first proposed by Corradi. Loreta and Barwell both inserted wire into an aneurysm before Corradi, but Corradi inserted wire and also used electricity. Corradi's operation can be used when distal ligation cannot be carried out, and can be used even when the vessel is extremely atheromatous. It finds its chief use in aneurysms of the thoracic aorta and innominate. In some cases of abdominal aneurysm the belly has been opened and the operation carried out. Some

[1] See John Duncan, in Heath's *Dictionary*.

cases have been notably improved, and one of Stewart's cases was apparently cured.[1] The operation is performed with aseptic care. If the thoracic aorta is to be operated upon, an anesthetic is not required. If the abdominal aorta is to be wired, the patient must be anesthetized. The wire used must have been previously drawn, so that it will easily pass through a hypodermatic needle and will coil up spirally within the sac (Stewart). The best wire is of silver or gold. It is a great mistake, Stewart says, to introduce a large quantity. He considers that a globular sac three inches in diameter requires from three to five feet, and a sac five inches in diameter requires from eight to ten feet. A hypodermatic needle, insulated up to one-quarter inch of the point, is carried into the interior of the aneurysm through a fairly thick portion of the sac. The required amount of wire is introduced. The wire is attached to the positive pole of the battery. The negative pole is fastened to a large flat piece of clay or a pad of moistened absorbent cotton, and the negative electrode is placed upon the back or abdomen. The current is turned on gradually until the necessary strength is obtained (40 to 80 ma.). When ready to terminate the operation the current is lowered gradually to zero, the needle is withdrawn, the wire is cut off close to the skin, and the end is pushed under the skin and the puncture is covered with iodoform collodion. The entire operation requires from three-quarters of an hour to one and a half hours.[2] A clot forms with considerable rapidity and expansile pulsation may lessen or cease. The operation can be repeated if necessary.

Traumatic aneurysm is a condition in which, after puncture or rupture of an artery, a sac has formed of tissue, and if any wound previously existed, it has healed. The treatment consists in ligation by the method of Antyllus, or complete excision. When an artery ruptures and a large mass of blood is extravasated into the tissues no sac exists, and it is an error to designate this condition as a diffuse traumatic aneurysm. In traumatic aneurysm, a large, oblong, fluctuating swelling is found. If the rent is large, there are bruit and pulsation. There is no pulsation in the arteries below the aneurysm, and the limb is cold and swollen. The skin is at first of a natural color, but becomes thin and purple. If the main vein is also ruptured, or if the rupture has

[1] D. D. Stewart, in *Phila. Med. Jour.*, October 12, 1898.

[2] The above description is condensed from that of D. D. Stewart, in *Phila. Med. Jour.*, November 12, 1898.

occurred into a large joint, amputate; otherwise perform the operation of Antyllus.

Arteriovenous aneurysm is an unnatural passage-way between a vein and an artery, through which passage blood circulates. There are two forms: (*a*) *aneurysmal varix*, or Pott's aneurysm, a vein and an artery directly communicating; and (*b*) *varicose aneurysm*, a vein and artery communicating through an intervening sac. These conditions arise usually from punctured wounds, the instrument passing through one vessel and into the other, blood flowing into the vein, the subsequent inflammation gluing the two vessels together, and the aperture failing to close (aneurysmal varix, Fig. 74). After the infliction of the wound the two vessels may separate; the blood continuing to flow from artery into vein, and the blood-pressure, by consolidating tissue, forming a sac of junction (varicose aneurysm, Fig. 75). Aneurysmal varix is a far less grave disorder than varicose aneurysm.

Symptoms.—In aneurysmal varix a swelling exists with the characteristic pulsation, and a loud whirring bruit is transmitted along the veins. The veins above and below the tumor are enlarged, tortuous, and pulsating. A distinct thrill is felt. Pressure over the tumor arrests the thrill and greatly lessens the bruit. The extremity is apt to be swollen and the parts are usually painful. When pressure on the main artery causes the entire disappearance of the tumor,

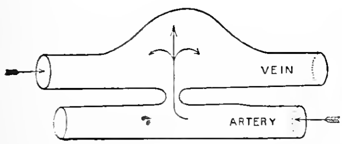


FIG. 74.—Plan of an aneurysmal varix.

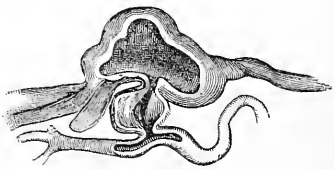


FIG. 75.—Varicose aneurysm (Spence).

the case is one of aneurysmal varix; but if on applying this pressure the veins collapse and a distinct tumor remains which may be emptied by direct pressure, the case is one of varicose aneurysm. If light pressure on one spot stops both murmur and thrill, the disease is aneurysmal varix. The diagnosis between the two is often impossible.

Treatment.—Aneurysmal varix often requires only palliative measures, as it does not tend to rupture, the vein becoming thick and resistant and after a time ceasing to enlarge. Some form of support is used. If the part is painful or the vein is in danger of rupture, tie the artery

above and below the opening, or ligate both vessels and excise them for some little distance each side of the point of trouble. Varicose aneurysm requires the use of the plans ordinarily adopted in treating aneurysm (compression, etc.). If these fail, tie the artery above and below the opening without opening the sac, or excise the involved areas of vein and artery, and also the sac.

Cirsoid aneurysm, or **aneurysm by anastomosis,** consists in great dilatation with pouching and lengthening of one or several arteries. The disease progresses and after a time involves the veins and capillaries. The walls of the arteries become thin and the vessels tend to rupture. Cirsoid aneurysm is met with upon the forehead and scalp of young people, where it sometimes takes origin from a nevus.

Symptoms.—There is a pulsating mass, irregular in outline, composed of dilated, elongated, and tortuous vessels that empty into one another. The mass is soft, can be much reduced by direct pressure, and is diminished by compression of the main artery of supply. A thrill and a bruit exist. Pregnancy and puberty cause rapid growth of a cirsoid aneurysm.

Treatment.—In treating a cirsoid aneurysm the ligation of the larger arteries of supply is a wretched failure. Subcutaneous ligation at many points of the diseased area has effected cure in some cases, but it has failed in more. Direct pressure is also entirely useless. Ligation in mass has been successful. Destruction by caustic has its advocates. Electropuncture with circular compression of the arteries of supply has once or twice effected a cure. Injection of astringents has been recommended. Verneuil ligated the afferent arteries, incised the tissues around the tumor, and sunk a constricting ligature into the cut. The proper method of treatment is excision after subcutaneous or open ligation of every accessible tributary of supply.[1]

Wounds of Arteries are divided into contused, incised, lacerated, punctured, and gunshot-wounds, and vascular ruptures.

Contused and Incised Wounds.—A contusion may destroy vitality and be followed by sloughing and hemorrhage. A contusion may rupture a blood-vessel, and is especially apt to do so if the vessel is diseased. Blood is at once effused at the seat of rupture. If an artery is ruptured, there may or may not be a bruit and pulsation over the seat of rupture, pulse is absent below, and the leg below the

[1] Anderson, in Heath's *Dictionary of Practical Surgery*.

injury swells and becomes cold. If a large vein ruptures, a blood tumor forms, which does not pulsate and has no bruit, and the limb below becomes intensely edematous. Gangrene is apt to follow the rupture of a main blood-vessel of an extremity. A contusion may rupture the internal and middle coats of an artery, the external coat remaining intact. When this happens the internal coat curls up and the middle coat contracts and retracts, the blood-stream is arrested, and a large clot forms within the artery. If the clot blocks up many collaterals, gangrene will follow, and, as has been pointed out, the gangrene will not be preceded by swelling at the seat of injury, which always occurs if a vessel is ruptured. A contused wound may do little damage, or it may produce gangrene from thrombosis, or it may cause secondary hemorrhage. In an incised wound of an artery there is profuse hemorrhage. The

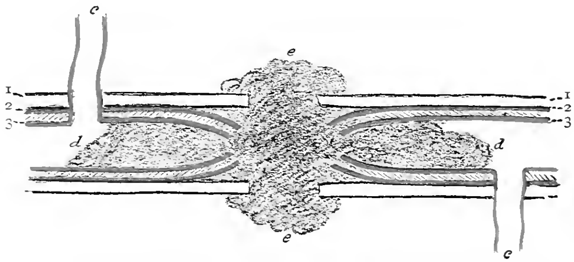


FIG. 76.—Clots formed after division of an artery: 1, 2, 3, outer, middle, and inner coats; *c, c*, branches; *d, d*, internal clot; *e, e*, external clot.

artery after a time is apt to contract and retract, bleeding being thus arrested. A transverse wound causes profuse bleeding, but there is a better chance for natural arrest than in an oblique or in a longitudinal wound. The clot which forms within a cut artery is known as the "internal clot;" it reaches as high as the first collateral branch, and subsequently is replaced by fibrous tissue, which permanently obliterates the vessel, and converts it into a shrunken fibrous cord. Between the vessel and its sheath, over the end of the vessel, and in the surrounding perivascular tissues is the "external clot" (Fig. 76).

A **lacerated wound** of an artery causes little primary hemorrhage. The internal coat curls up, the circular muscular fibers of the media contract upon it, the longitudinal fibers retract and draw the vessel within the sheath, and the external coat becomes a cap over the orifice of the vessel

—all of these conditions favor clotting. The vessel-wall is so damaged that secondary hemorrhage is usual.

Punctured Wounds.—In punctured wounds primary hemorrhage is slight unless a large vessel is punctured. Secondary hemorrhage is not common. Traumatic aneurysm and arteriovenous aneurysm are not unusual results.

Gunshot-wounds are apt to be contusions which may eventuate in sloughing and secondary hemorrhage or thrombosis and gangrene. A shell-fragment makes a lacerated wound. A modern rifle-bullet makes a clean-cut division of an artery. Secondary hemorrhage after gunshot-wounds is most likely to occur during the third week after the injury. Partial rupture of an artery may cause sloughing and secondary hemorrhage, thrombosis and gangrene, or aneurysm. A complete rupture constitutes a lacerated wound, and is a condition accompanied by diffuse hemorrhage into the tissues.

Wounds of veins are classified as are wounds of arteries. The symptom of any vascular wound is hemorrhage.

1. Hemorrhage, or Loss of Blood.

Hemorrhage may arise from wounds of arteries, veins, or capillaries, or from wounds of the three combined. In arterial hemorrhage the blood is scarlet and appears in jets from the proximal end of the vessels, which jets are synchronous with the pulse-beats; the stream, however, never intermits. The stream from the distal end is darker and is not pulsatile. Venous hemorrhage is denoted by the dark hue of the blood and by the continuous stream. In capillary hemorrhage red blood wells up like water from a squeezed sponge, and the color is between the bright red of arterial blood and the dark color of venous blood.

In subcutaneous hemorrhage from rupture of a large blood-vessel there are great swelling, cutaneous discoloration, and systemic signs of hemorrhage. If a main artery ruptures in an extremity, there is no pulse below the rupture, and the limb becomes cold and swollen. At the seat of rupture a large fluctuating swelling forms, and sometimes there are bruit and pulsation. If a vein ruptures in an extremity, a large, soft, non-pulsatile swelling arises, there is no bruit, and intense edema occurs below the seat of rupture. Profuse hemorrhage induces constitutional symptoms, and death may occur in a few seconds. Loss of half of the blood will usually cause death (from four to six pounds), though women can stand the loss of a greater rela-

tive proportion of blood than men. Young children, old people, individuals exhausted by disease, drunkards, sufferers from Bright's disease, diabetes, and sepsis stand loss of blood very badly. Generally, after the bleeding has gone on for a time syncope occurs, which is Nature's effort to arrest hemorrhage, for during this state the feeble circulation and the increased coagulability of blood give time for the formation of an external clot. When reaction occurs the clot may hold and be reinforced by an internal clot, or it may be washed away with a renewal of bleeding and syncope. These episodes may be repeated until death supervenes. Nausea exists. There may be regurgitation from the stomach, and vertigo is present. There is dimness of vision or everything looks black; black specks float before the eyes (muscæ volitantes), or the patient sees flashes of light or colors. There is a roaring sound in the ears (tinnitus aurium). The patient is restless and tosses to and fro, and great thirst is complained of. The mind may be clear, but delirium is not unusual, and convulsions often occur. After a profuse hemorrhage an individual is intensely pale and his skin has a greenish tinge; the eyes are fixed in a glassy stare and the pupils are widely dilated, and react slowly to light; the respirations are shallow and sighing; the skin is covered with a cold sweat; the legs and arms are extremely cold; the pulse is soft, small, compressible, fluttering, or often cannot be detected; the heart is very weak and fluttering; there is muscular tremor; the patient tosses about, and asks often and in a feeble voice for water. The suffering from thirst is terrible and no amount of water gives relief. There is often dreadful dyspnea, and a man who is bleeding to death grasps at his chest, rises up upon his elbow, and then falls back in a dead faint. Usually reaction occurs, though the patient is obviously weaker than before; again a faint may happen, and so there is fainting spell after fainting spell until death ensues. Convulsions frequently precede death. In hemorrhage the hemoglobin is greatly diminished in amount. In an interabdominal hemorrhage the above symptoms are noted, and, except in splenic hemorrhage, blood gathers in both loins, and dulness on percussion exists which gradually rises and shifts as the patient's position is shifted. The blood also gathers in the rectovesical pouch in the male, and in the recto-uterine pouch in the female, and may be detected by digital examination. If the spleen is wounded, the blood clots quickly, and an area of dulness, which does not shift and which progressively increases, is noted in the

splenic region. When such a dangerous condition is due to a visible hemorrhage, a large vessel in an extremity having been divided, temporarily arrest bleeding by digital pressure in the wound, or the application of an Esmarch band above the wound (if the bleeding is arterial). In some cases forced flexion is used. Lower the head, and have compression made upon the femorals and subclavians, so as to divert more blood to the brain, or bandage the extremities (auto-transfusion). Apply artificial heat. Inject by hyperdermoclysis the normal salt solution (10 to 16 ounces) into the cellular tissue of the buttock, or infuse the salt solution into a vein, inject ether hypodermatically, then brandy, and then strychnin in doses of gr. $\frac{1}{20}$. Atropin, digitalis, and morphin are recommended. Give enemata of hot coffee and brandy. Apply mustard over the heart and spine. Lay a hot-water bag over the heart. As soon as reaction is established, arrest the bleeding permanently by the ligature. In intra-abdominal hemorrhage open the abdomen, in spite of the weakened condition of the patient, and arrest the bleeding. In hemorrhage into the belly there is no way of temporarily arresting it before bringing about reaction and permanently arresting it. The radical course must be followed at once.

A severe hemorrhage is apt to be followed by fever, due to the absorption of fibrin ferment from extravasated blood and its action upon a profoundly debilitated system. In this form of fever there are most intense thirst, violent headache, dimness of vision, great restlessness, often mental wandering, with a very frequent, weak, and fluttering heart. After a severe hemorrhage leukocytes are increased, not only relatively but absolutely. Red corpuscles are diminished both relatively and absolutely. Hemoglobin diminishes; many of the corpuscles become irregular and microcytes are noticed.

In treating a patient who has thoroughly reacted after a severe hemorrhage, apply cold to the head to prevent serous effusion into the brain. Aconite, morphin, and neutral mixture are given by the mouth. Fluids and ice are grateful. Frequently sponge the skin with alcohol and water (S. W. Gross). Milk punch, koumiss, and beef-peptonoids are given at frequent intervals.

Hemostatic agents comprise (1) the ligature; (2) torsion; (3) acupressure; (4) elevation; (5) compression; (6) styptics; (7) the actual cautery; and (8) forced flexion of limbs.

The ligature was known to the ancients, but was rediscovered by Ambroise Paré. The ligature may be made of

silk, floss-silk, or catgut. Whatever material is used must, of course, be rendered aseptic. The ligatures should be about ten inches long. The vessel to be tied must be drawn out with forceps and separated for a short distance from its sheath, but must not be separated to any con-

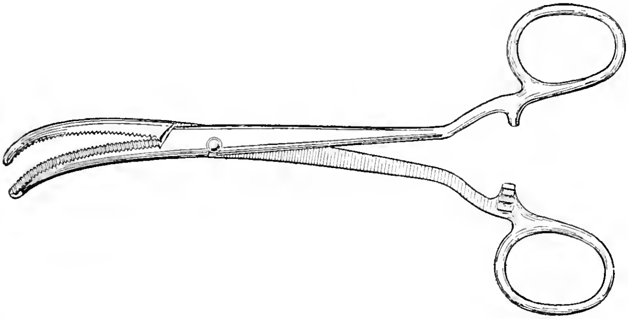


Fig. 77.—Curved hemostatic forceps.

siderable extent; to do so may lead to necrosis of the vessel and secondary hemorrhage. The hemostatic forceps (Figs. 77, 78). is in most cases a better instrument than the tenaculum (Fig 79). The tenaculum makes a hole in the vessel, and sometimes a slit-like tear. A portion of this opening may re-

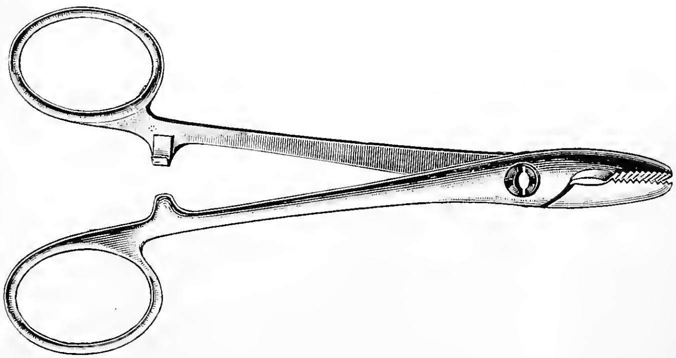


Fig. 78.—Straight hemostatic forceps.

main back of the tied ligature, the vessel may retract a little, or the ligature may slip slightly, and bleeding may occur. When the artery lies in dense tissues or is retracted deeply in muscle or fascia, the tenaculum, when carefully used, is the better instrument. The ligature is tied in a reef-knot (Fig. 80), not in a

granny-knot (Fig. 81), or in a surgeon's knot (Fig. 82). It is often the purpose of the surgeon to divide the internal and middle coats of the vessel, and if such is his desire the first knot is firmly tied. The second knot must not be tied too tightly,

FIG. 79.—Tenaculum.

or it will cut the ligature. The ligature must not be jerked as it is being tied, and both ends are to be cut off close to the knot. Both ends of a divided vessel should be ligated (Fig. 84). If a vessel is atheromatous, it is not desirable to divide the

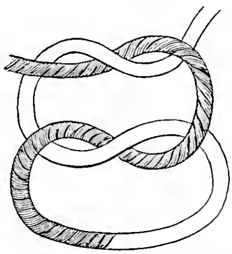


FIG. 80.—Method of tying square or reef-knot.

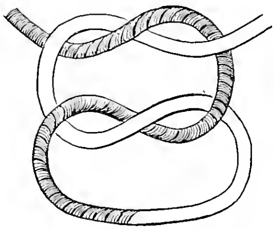


FIG. 81.—Method of tying granny knot.

internal and middle coats. In this case a ligature should be applied firmly rather than tightly, and another ligature should be put on above it, or ligation can be effected by the stay knot. If an artery is incompletely divided, a ligature should be

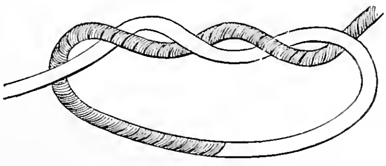


FIG. 82.—Method of tying surgeon's knot.

applied on each side of the wound, and the vessel divided between the ligatures. If a large vein is slightly torn, try to pinch up the vein-walls around the rent and apply a ligature (lateral ligature, Figs. 84, 93). If a vein is longitudinally torn, close the wound with a Lembert suture of silk (Ricard and

Niebergall have done this successfully). Murphy of Chicago has recently shown that longitudinal wounds or small lateral wounds of either veins or arteries can be closed successfully with silk sutures, and if a transverse wound includes more than one-third of the circumference of the vessel, after the vessel is completely divided the ends can be successfully

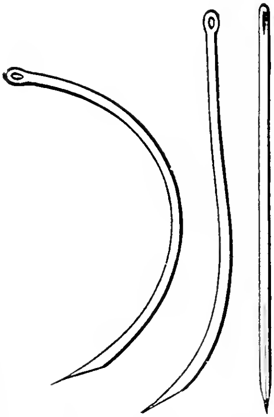


FIG. 83.—Hagedorn's needles.

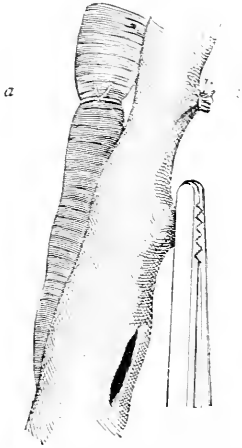


FIG. 84.—Method of controlling hemorrhage by ligature (after Esmarch): *a*, artery ligated; *b*, lateral ligature of vein.

united.[1] In extensive tears tie the vein in two places, and cut the vessel between the ligatures. If the bleeding comes from an artery very close to its point of origin, tie the main trunk as well as the bleeding branch, otherwise the clot formed will be very short and secondary hemorrhage will be inevitable. When the parts about an artery are so thickened that the artery cannot be drawn out, arm a Hagedorn needle (Fig. 83) with catgut and so pass the latter around the vessel that the catgut will include the vessel with some of the surrounding tissue, and tie the ligature (Fig. 85). This method is known as the application of a suture-ligature, and is pursued in necrosis, atheroma, scar-tissue, sloughing, etc. Never include a nerve of any size

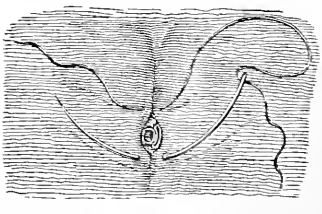


FIG. 85.—Arrest of hemorrhage by passing a suture-ligature.

[1] See *Medical Record*, Jan. 16, 1897.

in the ligature. If this mode of ligation fails, try acupressure.

Torsion.—Torsion was practised by the ancients, but was reintroduced in modern times, particularly by Amussat, Velpeau, Syme, and Bryant of London. By means of torsion the internal and middle coats are ruptured, and the external coat is twisted. The middle coat retracts and contracts, and the inner coat inverts into the lumen of the artery. It is a safe procedure, and is practised upon vessels as large as the femoral by many surgeons of high standing. Before the days of asepsis torsion possessed the signal merit of not introducing possible infection in ligatures. At the present time it offers no particular advantage. It is no quicker than the ligature, and damages the vessel so much that necrosis may occur. It cannot be used if the vessels are diseased.

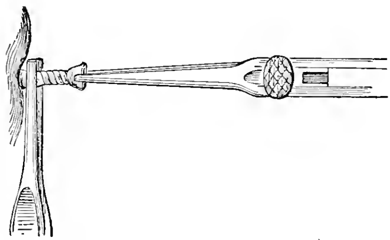


Fig. 86.—Method of controlling hemorrhage by torsion.

In what is known as free torsion the vessel is grasped, drawn out and twisted until the free end of the vessel is twisted off. Limited torsion is more often used. The vessel is drawn out of its sheath by a pair of forceps held horizontally, and is grasped a little distance above its extremity by another pair of forceps held vertically (Fig. 86). The first instrument is used to twist the artery six to eight times.

Acupressure is pressure with a pin. The method of hemostasis by acupressure was devised by Sir James Y. Simpson. A pin is simply passed under a vessel (transfixion), leaving a little tissue on each side between the pin and vessel. A needle can be passed under a vessel, and a wire be thrown over the needle and twisted (circumclusion). The needle can be inserted upon one side, passed through half an inch of tissues up to the vessel, be given a quarter-twist, and be driven into the tissues across the artery (torsoclusion). Some tissue may be picked up on the needle, folded over the vessel, and pinned to the other side (retroclusion). Acupressure is occasionally used to arrest hemorrhage in inflamed or ather-

omatous vessels, in sloughing wounds, in scar-tissue, and when a ligature will not hold.

Elevation is used as a temporary expedient or in association with some other method. It is of use in a wound of a bursa, in bleeding from a ruptured varicose vein, and is frequently used with compression.

Compression is either direct or indirect—that is, in the wound or upon its artery of supply. In the removal of the upper jaw arrest bleeding by plugging. In injury of a cerebral sinus, plug with gauze. Compression and hot water (115°–120° F.) will stop capillary bleeding. A graduated compress was formerly recommended in hemorrhage from the palmar arch. A compress will arrest bleeding from superficial veins. The knotted bandage of the scalp will arrest bleeding from the temporal artery. Long-continued pressure causes pain and inflammation.

Indirect compression is used to prevent hemorrhage or to temporarily arrest it. It may be effected by encircling a limb above a bleeding point with an Esmarch band or by applying a tourniquet or an improvised tourniquet (Fig. 87). It may also be effected by digital compression. Digital compression can be kept up only a few minutes by one person, but a relay of assistants can carry it

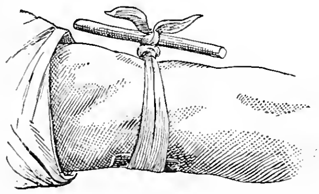


FIG. 87.—Impromptu tourniquet for compressing an artery with a handkerchief and a stick.

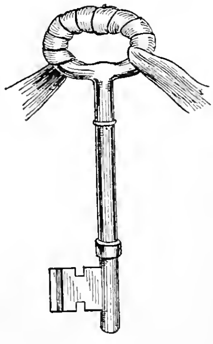


FIG. 88.—Handle of door-key, padded.

out for a considerable time. In compressing the subclavian, wrap a key as shown in Fig. 88, and compress the artery against the outer surface of the first rib. The shoulder must be depressed and pressure applied in the angle between the posterior border of the sternocleidomastoid and the upper border of the clavicle. The direction of the pressure should be downward, backward, and inward.

The brachial artery can be compressed against the humerus. In the upper part of the course of the artery the

pressure should be from within outward (Fig. 89), in the lower part from before backward (Fig. 90). The abdominal aorta can be compressed by Macewen's method. The common iliac can be compressed through the rectum by means

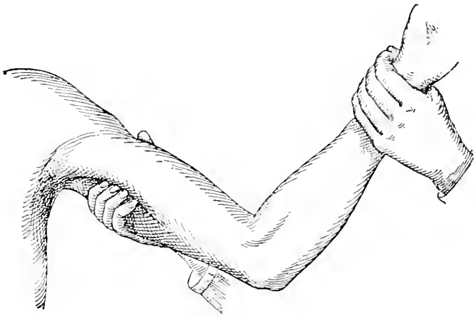


FIG. 89.—Digital compression of the brachial artery.

of a round piece of wood known as Davy's lever. The femoral artery can be compressed just below Poupart's ligament against the psoas muscle and head of the femur

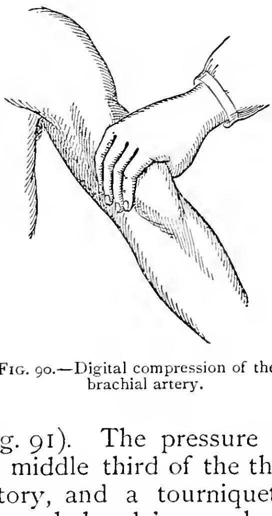


FIG. 90.—Digital compression of the brachial artery.

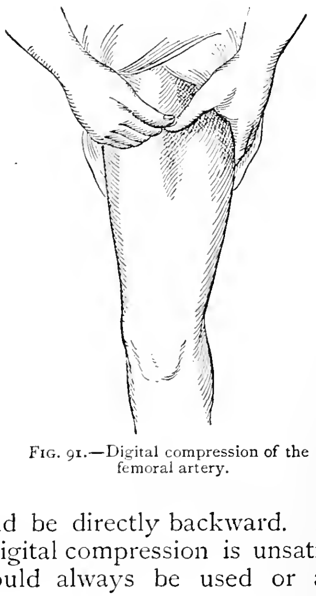


FIG. 91.—Digital compression of the femoral artery.

(Fig. 91). The pressure should be directly backward. In the middle third of the thigh digital compression is unsatisfactory, and a tourniquet should always be used or an Esmarch band be employed.

Forced flexion is a variety of indirect compression introduced by Adelmann. It will arrest bleeding below the point compressed, but soon becomes intensely painful. Forced flexion can be maintained by bandages. Brachial hyperflexion is maintained by tying the forearm to the arm. It is often associated with the use of a pad in front of the elbow. Genuflexion is kept up by tying the foot to the thigh. It is increased in efficiency by placing a pad in the popliteal space.

Styptics.—Chemicals are now rarely used to arrest hemorrhage. In epistaxis we may pack with plugs of gauze saturated with a 10 per cent. solution of antipyrin. In bleeding from a tooth-socket freeze with chlorid of ethyl spray, and then pack with gauze soaked with 10 per cent. solution of antipyrin or pack with styptic cotton (absorbent cotton soaked in Monsel's solution and dried). A bit of cork may be forced into the socket. In bleeding from an incised urinary meatus pack with styptic cotton and compress the lips of the meatus. Cold water, chlorid of ethyl spray, and ice act as styptics by producing reflex vascular contraction. Hot water produces contraction and coagulates the albumin. The temperature should be from 115° to 120° F. A mixture of equal parts of alcohol and water stops capillary oozing. Paul Carnot has recently shown that a solution of gelatin in normal salt solution (2 per cent.) will arrest capillary oozing even in a hemophiliac. We have of late employed this mixture with satisfactory results for capillary oozing from an incised wound in a victim of leukemia, and for the arrest of epistaxis. Carnot's solution, as at present used, consists of 5 parts of gelatin, 1 part of calcium chlorid, and 100 parts of water, and the mixture is sterilized by heat.

The actual cautery is a very ancient hemostatic. It is still used in some cases after excising the upper jaw, in bleeding after the removal of some malignant growths, in continued hemorrhage from the prostatic plexus of veins after lateral lithotomy, and to stop oozing after the excision of venereal warts. We are often driven to its use in "bleeders"—that is, those persons who have a hemorrhagic diathesis, and who may die from having a tooth pulled or from receiving a scratch. It will arrest hemorrhage, but the necrosed tissue separates, and when it separates secondary hemorrhage is apt to set in. The iron for hemostatic purposes must be at a cherry heat. The old-fashioned iron, which was heated in a charcoal furnace, is rarely used. It is large,

clumsy, and cools quickly if the bleeding is profuse. In an emergency we may heat a poker or a coil of telegraph wire. The best instrument is the Paquelin cautery. The Paquelin cautery consists of an alcohol lamp, a metal chamber containing benzene, a tube of entrance for air containing two bulbs, an exit tube, and a wooden-handled cautery instrument, the tip of which is composed of spongy platinum (Fig. 92). This can be kept hot even when bleeding is profuse. If the iron is very hot, it will not stop bleeding completely. In order to use the Paquelin cautery, light the lamp, heat the cautery-tip in the flame until it becomes red, remove it from the flame, and squeeze the bulb repeatedly until the tip becomes

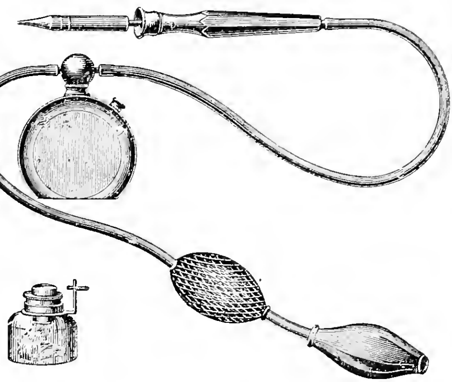


FIG. 92.—Paquelin cautery.

bright red. Each time the bulb uncovered with netting is squeezed air is driven through the metal chamber into the tube and cautery, and this air carries with it the vapor of benzene, which passes to the hot tip and takes fire. The degree of heat maintained depends upon the rapidity with which the bulb is squeezed.

Skene has devised a method known as electrohemostasis. He grasps the vessel or tissue with specially constructed forceps, an electric current generates heat, the tissue is cooked and the walls of the vessel united. A heat of from 180°–190° F. is required. For the small instrument Skene uses a current of 2 ma. and for the larger instrument a current of 8 ma.[1]

Golden Rules for Procedure in Primary Hemorrhage.—1. In arterial hemorrhage tie the artery in the wound, enlarging the wound if necessary. In tying the main artery of the

[1] *New York Medical Journal*, February 18, 1898.

limb in continuity for bleeding from a point below we fail to cut off the bleeding from the distal extremity, and hemorrhage is bound to recur. If we do not look into the wound, we cannot know what is cut: it may be only a branch, and not a main trunk. The same rule obtains in secondary hemorrhage (Guthrie's rule).[1]

2. We can safely ligate veins as we would arteries.

3. In a wound of the superficial palmar arch tie both ends of the divided vessel.

4. In a wound of the deep palmar arch enlarge the wound, if necessary, in the direction of the flexor tendons, at the same time maintaining pressure upon the brachial artery. Catch the ends of the arch with hemostatic forceps and tie both ends. If the artery can be caught by, but cannot be tied over the point of, the forceps, leave the instrument on for four days. If the artery cannot be caught with forceps, use a tenaculum. The ends of the divided vessel can be caught and must be caught even if large incisions are needed to effect it. An incision which will probably always expose the vessel is as follows: Make a cut on a line with the injury from the web of the fingers to above the carpus separating the metacarpal and carpal bones until the artery is reached. (This is really Mynter's incision for excision of the wrist.) In former days if the surgeon found trouble in grasping the ends of the vessel, he applied a graduated compress. This is applied as follows: Insert a small piece of gauze in the depths of the wound, put over this a larger piece, and keep on adding bit after bit, each successive piece larger than its predecessor, until there exists a conical pad, the apex of which is at the point of hemorrhage and the base of which is external to the surface of the palm. Bandage each finger and the thumb, put a piece of metal over the pad, wrap the hand in gauze, place the arm upon a straight splint, apply firmly an ascending spiral reverse bandage of the arm, starting as a figure-of-8 of the wrist, and hang the hand in a sling. Instead of applying a splint, we may place a pad in front of the elbow and flex the forearm on the arm. The palmar pad is left in place for six or seven days unless bleeding continues or recurs. The graduated compress is an unreliable, hence a dangerous, method of treatment. It is an evasion. It should be employed at the present time only as a temporary expedient, until ligatures can be applied. The old rule of surgery was as follows: If bleeding is maintained or begins again after application of a graduated com-

[1] For Murphy's observations on anastomosis of vessels, see page 261.

press, ligate the radial and ulnar arteries. If this maneuver fails, we know that the interosseous artery is furnishing the blood and that the brachial must be tied at the bend of the elbow. If this fails, amputate the hand. At the present day it is hard to conceive of such radical procedures being necessary for hemorrhage.

5. In primary hemorrhage, if the bleeding ceases, do not disturb the parts to look for the vessel. If the vessel is clearly seen in the wound, tie it; otherwise do not, as the bleeding may not recur. This rule does not hold good when a large artery is probably cut, when the subject will require transportation (as on the battle-field), when a man has delirium tremens, mania, or delirium, or when he is a heavy drinker. In these cases always look for an artery and tie it.

6. When a person is bleeding to death from a wound of an extremity, arrest hemorrhage temporarily by digital pressure in the wound and apply above the wound a tourniquet or Esmarch bandage. Bring about reaction and then ligate, but do not operate during collapse if the bleeding can be controlled by pressure.

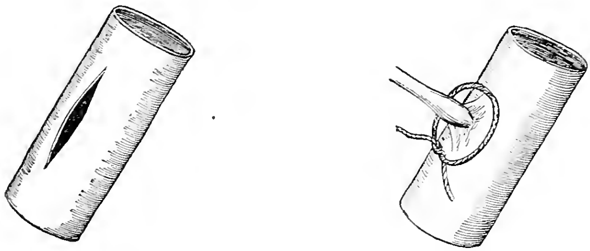


FIG. 93.—Application of lateral ligature to a vein.

7. If a transverse cut incompletely divides an artery, it may be found possible to suture the cut if it does not include more than one-third of the circumference of the vessel. Longitudinal cuts can be sutured (Murphy). If suturing is impossible, or if the surgeon prefers not to attempt it, apply a ligature on each side of the vessel-wound and then sever the artery so as to permit of complete retraction.

8. If a branch comes off just below the ligature, tie the branch as well as the main trunk.

9. If a branch of an artery is divided very close to a main trunk, tie the branch and also the main trunk. If the branch alone be tied, the internal clot, being very short, will be washed away by the blood-current of the larger vessel.

10. If a large vein is slightly torn, put a lateral ligature upon its wall (Fig. 93). Gather the rent and the tissue around it in a forceps and tie the pursed-up mass of vein-wall. It is a wise plan to pass the suture through the two outer coats by means of a needle and tie the knot subsequently. This expedient prevents slipping. If a longitudinal wound exists in a large vein, take an intestinal needle and fine silk and sew it up with a Lembert suture.

11. When a branch of a large vein is torn close to the main trunk, tie the branch, and not the main trunk. Apply practically a lateral ligature.

12. If, after tying the cardial extremity of a cut artery, the distal extremity cannot be found, even after enlarging the wound and making a careful search, firmly pack the wound.

13. In bleeding from diploë or cancellous bone, use Horsley's antiseptic wax, or break in bony septa with a chisel, or plug with threads of gauze or scrapings of catgut.

14. In bleeding from a vessel in a bony canal, plug the canal with an antiseptic stick and break the wood, or fill up the orifice of the canal with antiseptic wax; or, if this fails, ligate the artery of supply.

15. In bleeding from the internal mammary artery the old rule was to pass a larged curved needle holding a piece of silk into the chest, under the vessel and out again, and tie the thread tightly, but it is better to ligate the artery.

16. In bleeding from an intercostal artery make pressure upward and outward, or throw a ligature by means of a curved needle entirely over a rib, tying it externally, or, what is better, resect a rib and tie the artery.

17. In collapse due to puncture of a deep vessel, the bleeding having ceased, do not hurry reaction by stimulants. Give the clot a chance to hold. Wrap the sufferer in hot blankets. If the condition is dangerous, however, stimulate to save life.

18. In punctured wounds, as a rule, try pressure before using ligation.

19. After a severe hemorrhage *always* put the patient to bed and elevate the damaged part (if it be an extremity or the head).

20. A clot which holds for twelve hours after a primary hemorrhage will probably hold permanently; but even after twelve hours be watchful and insist on rest.

21. If recurrence of a hemorrhage from a limb is feared, mark with anilin or iodin the spot on the main artery where compression is to be applied, apply a tourniquet loosely, and order the nurse to screw it up and to send for the physician

at the first sign of renewed bleeding. This must often be done in gunshot-wounds.

22. When the femoral vein is divided high up the advice commonly given is to ligate the vein and also the femoral artery. Braune taught that because of the venous valves there is no collateral circulation, and to tie the vein alone renders gangrene inevitable. Niebergall shows that the valves may be overcome by moderate arterial pressure, and thus collateral circulation be established. Hence, when the femoral vein is divided tie the vein, but leave the artery untied, so as to furnish the necessary pressure.[1]

23. In extradural hemorrhage trephine. The side to be trephined is determined by the symptoms, and not by the situation of the injury. The opening is made on a level with the upper orbital border and one and a quarter inches behind the external angular process. This opening exposes the middle meningeal and its anterior branch (Keen). If this does not expose a clot, trephine over the posterior branch, on the same level and just below the parietal eminence. When the clot is found enlarge the opening with the rongeur, scoop out the clot, and arrest the bleeding by passing catgut ligatures on each side of the injury in the vessel through the dura, under the artery and out again, and then tying them. If the artery lies in a bony canal, plug the canal with Horsley's wax. In subdural hemorrhage open the dura and endeavor to ligate. If this procedure is impossible, pack with *one* piece of iodoform gauze.

24. In hemorrhage from a cerebral sinus catch the edges of the opening with forceps, if possible, and apply a lateral ligature, or leave the forceps in place for forty-eight hours or compress firmly with *one* large piece of iodoform gauze.

25. In extramedullary spinal hemorrhage rapidly advancing and threatening life perform a laminectomy and arrest the hemorrhage.

26. In bleeding from a tooth-socket use chlorid-of-ethyl spray or ice. If this treatment fails, plug with gauze infiltrated with tannin or soaked in antipyrin solution of a strengh of 10 per cent., or in Carnot's solution of gelatin, close the jaws upon the plug, and hold them with Barton's bandage. If this expedient fails, soak the plug in Monsel's solution, or plug with a bit of cork, and if this is futile, use the cautery. Pressure on the carotid and ice over the jaw and neck are indicated. It may be necessary to tie the external carotid artery.

[1] Niebergall, *Deut. Zeit. f. Chir.*, vol. xxxvii., Nos. 3 and 4.

27. In intra-abdominal hemorrhage open the belly. In intra-abdominal hemorrhage it is necessary to operate during shock. If the blood accumulates so rapidly as to prevent the location of the bleeding point, compress the aorta or pack the abdominal cavity with large sponges. In seeking for the bleeding point remove the sponges one by one, or have the pressure momentarily relaxed from time to time. In parenchymatous hemorrhage try packing with iodoform gauze. In the liver, if this fails, suture the torn edge or use the cautery. Severe wounds of the spleen demand splenectomy. Wounds of the kidney may be sutured, but may require partial or complete nephrectomy. Mesenteric vessels are ligated *en masse* with silk (Senn). Wounds of the stomach and intestines causing hemorrhage require stitching of their edges. When there are an infinite number of points of bleeding take a number of sponges, tie a piece of tape firmly to each one, pack many places in the belly with the sponges, bring the tapes out of the wound, and remove the sponges from below upward one at a time, securing the bleeding points as they come into view.

28. In abdominal section for disease of the female pelvic organs bleeding is limited by the clamp or by pressure-forceps. Ligation *en masse* is often practised. Use silk. A large mass can be transfixed and tied in sections. Bleeding edges are stitched. Areas of oozing are treated with temporary pressure and hot water, or, if this fails, by the cautery. Packing can be used as a tamponade, which is a gauze pouch, pieces of gauze being packed into this pouch after its insertion into the belly.

29. A ruptured varicose vein requires a compress, a bandage from the periphery up, and elevation.

30. Most cases of capillary bleeding can be controlled by compression with gauze pads soaked in water at a temperature of 115° to 120° F. This contracts the vessels and seals them with coagulated albumin. Keetly in 1878 impressed the profession with the value of hot water as a styptic. Centuries ago surgeons used hot oil for the same purpose. Capillary bleeding can often be controlled by the application of gauze soaked in Carnot's solution. Carnot's original solution was gelatin in normal salt solution, 2 parts of gelatin to 100 parts of salt solution. He now uses 5 parts of gelatin, 1 part of chlorid of calcium, and 100 parts of water sterilized by heat. A 2 per cent. solution of suprarenal extract may control capillary oozing. If other means fail to control capillary hemorrhage, the cautery must be used. Understand

that the term capillary bleeding does not so much mean bleeding from genuine capillaries as it does bleeding from arterioles and venules.

31. Pressure above a wound arrests arterial hemorrhage, but aggravates venous bleeding. Pressure below a wound arrests venous hemorrhage, but increases arterial bleeding. Remember these facts when applying pressure.

32. A moderate epistaxis may be arrested by an injection of peroxid of hydrogen, an injection of a solution of antipyrin, or an injection of Carnot's solution of salt and gelatin. Favorite domestic expedients are keeping the arms raised above the head and applying ice to the back of the neck. In severe

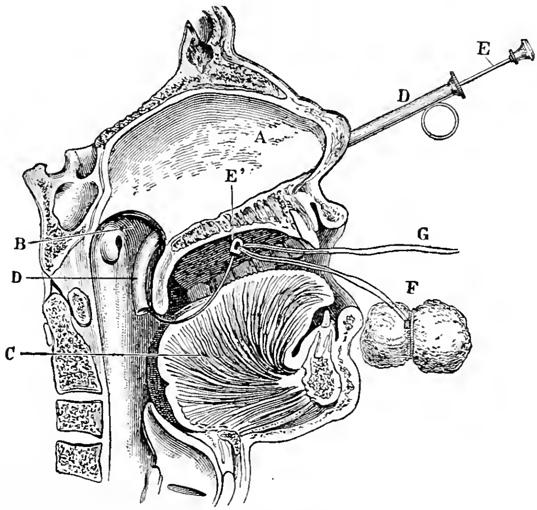


Fig. 94.—Plugging the nares for epistaxis (Guerin).

epistaxis, or bleeding from the nose, examine the nose by means of a head-mirror and a speculum. If a little point of ulceration is found, touch it with a hot iron. If the bleeding is a general ooze, if it is high up, or if the cautery does not arrest it, pack the nares. It may be necessary to pack one nostril or both. Pass a Bellocq cannula (Fig. 94) along the floor of one nostril into the pharynx, project the stem into the mouth, tie a plug of lint or gauze wet with Carnot's solution of salt and gelatin to the stem, and withdraw it. Hold the double string which emerges from the nostril in the hand and pack gauze wet with gelatin solution from before backward. Tie the strings together over the plug; if both nostrils

are plugged, the strings from one nostril are fastened to the strings from the other. Do not use subsulphate of iron, as it forms a disgusting, clotty, adherent mass. If a Bellocq cannula is not obtainable, push a soft catheter into the pharynx, catch it with a finger, pull it forward, and tie the plug to it. Remove the plug in two or three days. Do not leave it longer. It blocks up decomposing fluids and may lead to blood-poisoning. Pick out the front plug first, hold the string of the second plug in the hand, push the plug back into the pharynx, catch it with forceps, and withdraw plug and string through the mouth.

33. In gunshot-wounds the primary hemorrhage is slight unless a large vessel is cut. The bleeding may be visible or may be internal (concealed), the blood running into a natural cavity or among the muscles. Capillary oozing is arrested by very hot water and compression. Venous bleeding is usually arrested by compression. If a large vessel is the source of bleeding, enlarge the wound and tie the vessel. If the artery cannot be found in the wound, tie the main trunk.

34. In prolonged bleeding from a leech-bite try compression over a plug saturated with alum or with tannin. If this fails, pass under the wound a harelip-pin and encircle it with a piece of silk. If this fails, use the actual cautery or excise the bite and suture the incision.

35. In severe bleeding from the ear elevate the head, put an ice-bag over the mastoid, give opium and acetate of lead, and, if blood runs into the mouth, plug the Eustachian tube with a piece of catheter.

36. Umbilical hemorrhage in infants requires pressure over a plug containing tannin, alum, or gelatin solution. If compression fails, pass harelip-pins under the navel and apply a twisted suture. If this fails, use the actual cautery.

37. Rectal bleeding requires elevation of the buttocks, insertion of plugs of ice, ice to the anus and perineum, astringent injections (alum), and the internal use of opium and acetate of lead. If these means fail, plug the bowel over a catheter, or insert and inflate a Paterson bag or a colpeurynter, or tampon and use a T-bandage. If the bleeding persists or if a considerable vessel is bleeding, stretch the sphincter, catch the bowel and draw it down, seize the vessel, and tie it if possible; if not, leave the forceps in place. Failing in this, the actual cautery must be used.

38. Subcutaneous hemorrhage, if severe and continuing, demands that an incision be made and ligatures be applied.

39. Bleeding from a cut urethral meatus requires the insertion of styptic cotton and the application of pressure. Moderate bleeding from the urethra can usually be arrested by a very warm bougie, by very warm injections, or by tying a condom over a catheter, and, after inserting it, inflating the condom by blowing through the catheter and plugging the orifice of the instrument, thus using pressure. Sitting with the perineum on a thickly folded towel is useful. Ice to the perineum does good. The patient can lie down, have a folded towel applied to the perineum, and a crutch-handle pushed upon the towel, the lower end of the crutch being jammed against the foot of the bed. If a solid bougie has been first introduced, firm pressure can be made by this method. If these means are futile, perform an external urethrotomy and reach the bleeding point.

40. Hemorrhage from the prostate requires hot injections, the introduction of a large bougie first dipped in very warm water, and the retention of a catheter for two days. Perineal section may be required, or suprapubic cystotomy with packing which does not occlude the ureteral orifices.

41. Vesical hemorrhage usually ceases spontaneously, in which case the urine must be drawn off and the viscus be washed out frequently with a solution of boric acid, to prevent septic cystitis. If blood-clots prevent the flow of urine, break them up with a catheter or a lithotrite and inject vinegar and water, a 2 per cent. solution of carbolic acid, or a solution of bicarbonate of sodium. Perfect quiet is to be maintained, cold acid drinks to be given, ice-bags to be put to the perineum and hypogastric region, and opium with acetate of lead, or gallic acid to be given by the mouth. If the hemorrhage is severe or persistent, perform a suprapubic cystotomy, wash out the bladder, and, if necessary, plug the bladder with gauze, leaving the ureters uncovered.

42. In hemorrhage after lateral lithotomy, ligate if possible. If the vessel can be caught but cannot be ligated, leave the forceps in place. If we cannot catch the vessel with forceps, use a tenaculum. If the tenaculum fails, pass a threaded curved needle through the tissues around the vessel and tie the ligature. Plugs of ice and injections of hot water may be tried. These means failing, pressure is indicated. Take a cannula, fasten to it a chemise (Fig. 95), empty clots from the bladder, insert the instrument into the viscus, and pack gauze between the sides of the cannula and the chemise. The chemise is bulged out and pressure

is made. Tie the cannula by means of tapes to a T-bandage. Pressure is thus combined with vesical drainage. Buckstone Brown makes pressure by inflating a rubber bag with air. The hot iron may occasionally be demanded.

43. Renal bleeding requires ice to the loin, tannic acid and opium, gallic acid or sulphuric acid internally, and perfect quiet. If the bleeding threatens life and the diseased organ is identified, make a lumbar incision, and suture or perform nephrectomy; if not sure which organ is diseased, perform an abdominal nephrectomy. The use of a cystoscope will show from which ureter blood is emerging.

FIG. 95.—Cannula à chemise.

44. Vaginal hemorrhage requires the ligature or the tampon.

45. Severe uterine hemorrhage (unconnected with pregnancy) requires the tampon. Persistent hemorrhage due to morbid growths may require removal of the tubes and appendages, ligation of the uterine and ovarian arteries, or hysterectomy.

46. Hematemesis, or bleeding from the stomach, is treated by the swallowing of ice, giving tannic acid (dose, 20 or 30 grains) or Monsel's solution (3 drops). Never give tannic acid and Monsel's solution at the same time, as they mix and form ink. Opium is usually ordered. Acetate of lead and opium and gallic acid are favorite remedies, and ergot is used by many. Give no food by the stomach. If life is threatened by bleeding from an ulcer, open the belly and excise the ulcer and suture the wound. If severe hemorrhage follows injury, make an exploratory laparotomy. Always remember that furious and even fatal gastro-intestinal hemorrhage may be due to cirrhosis of the liver. A slight injury may be the exciting cause of such a hemorrhage. In this condition, of course, operation is useless.

47. In bleeding from the small bowel give acetate of lead and opium, sulphuric acid, or Monsel's salt in pill form (3 grains), allow no food for a time, and insist on liquid diet for a considerable period. If hemorrhage threatens life, do a celiotomy and find the cause. If ulcer exists, excise it and suture, or suture a perforation without previously excising.

If violent hemorrhage follows injury, explore to discover the cause.

48. In bleeding from the large bowel, use styptic injections (10 grains of alum or 5 grains of bluestone to ℥j of water). If bleeding is low down, use small amounts of the solution; if high up, large amounts. Do not use absorbable poisons. In dangerous cases perform an exploratory operation to find the cause. (For rectal bleeding see 37, p. 343.)

49. Hemoptysis, or bleeding from the lung, is treated by morphin hypodermatically, by perfect rest, by dry cups or ice over the affected spot if it can be located, and by the administration of gallic acid, which drug aids coagulation.[1] Of late nitrite of amyl by inhalation has given good results.

50. In hemorrhage from wound of the lung do not open the chest unless life is threatened. If life is endangered, resect a rib, allow the lung to collapse, and see if this arrests bleeding. If bleeding still continues, remove several ribs, find the bleeding point, ligate or employ forcipressure. A small cavity may be packed with gauze. If a large surface is bleeding, fill the pleural sac with gauze and pack more gauze against the oozing surface.[2]

Reactionary or Recurrent Hemorrhage (called also Consecutive, Intermediate, or Intercurrent).—This form of hemorrhage comes on during reaction from an accident or an operation—that is, during the first forty-eight hours, but usually within twelve hours. It is bleeding from a vessel or vessels which did not bleed during the shock which accompanied operation, and which vessels were overlooked and not tied. It may be due to faultily applied ligatures. It is favored by vascular excitement or hypetrophied heart. The bleeding is rarely sudden and severe, but is usually a gradual drop or trickle. The Esmarch apparatus is not unusually the cause. The constricting band paralyzes the smaller arteries, which do not bleed during shock and do not contract as shock departs; hence bleeding comes on with reaction. To lessen the danger of the Esmarch apparatus use a broad constricting band rather than a rubber tube. After an amputation, when the larger vessels have been tied, gauze pads wet with hot water (115° to 120° F.) should be placed between the flaps. This not only arrests capillary oozing,

[1] The use of ergot is a general but questionable practice. Bartholow and others hold that this drug does harm; it contracts all the arterioles, and hence more blood flows from an area where there is damage. Purgatives do good in bleeding from the lung by taking blood to the abdomen and lowering blood-pressure.

[2] See author's case, *Annals of Surgery*, Jan., 1898.

but stimulates vessels and shows points of bleeding which were not previously visible, and these points are ligated. During reaction after an amputation, if slight hemorrhage occurs, elevate the stump and compress the flaps. If the hemorrhage persists or at any time becomes severe, make pressure on the main artery of the limb, open the flaps, turn out the clots, find the bleeding point, ligate, asepticize, close, drain, and dress. In any severe reactionary hemorrhage open the wound at once and ligate.

Secondary hemorrhage may occur at any time in the period between forty-eight hours after the accident or operation and the complete cicatrization of the wound. Secondary hemorrhage may be due to atheroma, to slipping of a ligature, to inclusion of nerve, fascia, or muscle in the ligature, to sloughing, to erysipelas, to septicemia, to pyemia, to gangrene, and to overaction of the heart. The great majority of cases of secondary hemorrhage are due to infection, and the application of modern surgical principles has rendered secondary bleeding a rare calamity. If during an operation the vessels are found atheromatous, a thread should be passed, by means of a Hagedorn needle, around the vessel, including a cushion of tissue in the loop of the ligature (this prevents cutting through, Fig. 85). Acupressure may be used in such a case. If the surgeon decides to employ the ligature, he must not tie tightly, but must endeavor to approximate the coats rather than to cut them. Two ligatures can be applied or the stay-knot may be used. One great trouble with atheromatous arteries is that their coats cannot contract; another trouble is that the ligature cuts entirely through them. If after an operation the pulse is found to be forcible, rapid, and jerking, give aconite, opium, and low diet. The bleeding may come on suddenly and furiously, but is usually preceded by a bloody stain in wound-fluids which had become free from blood.

Treatment of Secondary Hemorrhage.—Supposing a case of leg-amputation in which, several days after the operation, a little oozing is detected, the treatment is to elevate the stump, apply two compresses over the flaps, and carry a firm bandage up the leg. If the bleeding is profuse or becomes so, make pressure on the main artery, open and tear the flaps apart with the fingers, find the bleeding vessel and tie it, turn out the clots, asepticize, close, drain, and dress. If the bleeding begins at a period when the stump is nearly healed, cut down on the main artery just above the stump and ligate. In secondary hemorrhage from a blood-vessel

in nodular tissue, apply a suture-ligature or tie higher up, or, if this fails, amputate. When secondary hemorrhage arises in a sloughing wound apply a tourniquet or an Esmarch bandage, tear the wound open to the bottom with a grooved director, look for the orifice of the vessel, dissect the artery up until a healthy point is reached, cut it across, and tie both ends. If this fails, apply a suture-ligature or use acupressure. In secondary hemorrhage from atheromatous vessels, use the suture-ligature, double ligature with a stay knot, or employ acupressure.

Secondary hemorrhage may occur after ligation in continuity, the blood usually coming from the distal side. If the dressings are slightly stained with blood, put on a graduated compress. If the bleeding continues or is severe, make pressure on the main artery of the limb, open the wound and ligate, wrap the part in cotton, elevate, and surround with hot bottles. If this religation is done on the femoral and fails, do not ligate higher up, as gangrene will certainly occur, but amputate at once, above the point of hemorrhage. If dealing with the brachial artery, do not amputate, but ligate higher up and make compression in the wound. In a secondary hemorrhage from the innominate, tie the innominate again and also tie the vertebral.

2. Operations on the Vascular System.

Paracentesis auriculi, or tapping the heart-cavity, has been suggested for the relief of an over-distended heart from pulmonary congestion. The right auricle can be tapped. Push the aspirator-needle directly backward at the right edge of the sternum, in the third interspace. This operation is not recommended, as it is highly dangerous and is of questionable value.

Paracentesis pericardii, or tapping the pericardial sac, is only done when life is endangered by effusion. Introduce the needle two inches to the left of the left edge of the sternum, in the fifth interspace, and push it directly backward (thus avoiding the internal mammary artery).

Operation for Pericardial Effusion or Suppuration.—The operation of tapping should be abandoned in favor of a safer but more radical procedure. There is no spot where we can introduce the needle with perfect safety, and the heart or pleura may be wounded; further, as Brentano shows,[1] tapping will not completely empty the sac. In a

[1] *Deutsch. med. Woch.*, Feb. 11, 1890.

purulent case tapping gives practically no chance of cure. No general anesthetic should be used. A portion of the fifth rib or the cartilage on the fifth rib should be excised, the pericardium exposed and punctured in order to determine the nature of the fluid present. If the fluid is serous, it can be drained away through a small incision, and the pericardium may either be sutured or drained with gauze. If the fluid be purulent, the pericardium should be stitched to the chest-wall and opened. Clots should be removed by irrigation with hot salt solution and a drainage-tube should be introduced.

Operation for Varix of Leg.—Many cases do not require operation. In some, operation is positively harmful. In some selected cases it is very useful to remove certain complications (ulcer, ezcema, etc.), and to relieve the patient from annoyance, but the operation rarely absolutely cures the condition. The indications and contraindications are discussed on p. 307. Never operate if phlebitis exists, except to treat thrombosis.

Trendelenburg's Operation.—I have employed this with much satisfaction in cases of varix of the leg following involvement of the saphenous in the thigh. Trendelenburg believes that in varix the valves in the saphenous become incompetent because of high central pressure. The veins of the leg distend, as they are unable to support such a long column of blood, and finally the blood begins to flow in the wrong direction in the saphenous, a "vicious circle" being established.

Make an incision about four inches long over the internal saphenous vein at the junction of the lower and middle thirds of the thigh. Expose the vein, ligate each visible branch, ligate the saphenous at the lower end of the wound and also at the upper end, and remove the portion of vein included between the ligatures. By this operation the central pressure is intercepted and the dilated veins in consequence shrink. Some surgeons have advised the removal of the entire length of the long saphenous vein.

Madelung cuts down over the varices and ligates at various points. *Schede* makes a circular cut (a circumcision) completely around the leg at the junction of the upper and middle thirds, the incision reaching to the deep fascia. All bleeding points are ligated and the edges of the incision are stitched together. *Fergusson* ties the saphenous vein near the femoral and removes a section from it. This makes the varices clearly evident. A semi-

lunar incision is made to surround the varices, which incision reaches to the deep fascia. The flap is raised and dissected up, the vessels are tied, and the flap is sutured in place. The author of this operation claims that it is most satisfactory and certain. *Phelps* advises multiple ligation, which may be described as follows: At several points over the long saphenous vein make skin incisions in the long axis of the vessel. Each incision is two inches long. At each point apply two ligatures one inch apart and remove the portion of vein between them.

Open Operation for Varicocele.—The open operation is by far the best procedure for varicocele. The instruments used are a scalpel, an aneurysm-needle, curved needles, a grooved director, a dissecting-forceps, Allis's dry dissector, hemostatic forceps, and scissors.

Operation.—The patient is placed in a recumbent position. He may be given a general anesthetic or Schleich's fluid may be injected. The operator stands on the diseased side. The assistant stands on the sound side and makes pressure over the inguinal ring of the affected side. A fold of skin is pinched up on the scrotum, and the surgeon transfixes it in the line of the cord, so that he will have an incision about one and a half inches long running downward from below the external ring. The skin and fascia are cut with a scalpel, the veins are well exposed by means of an Allis dissector, and the cord is located and held aside. A double ligature of strong catgut or chromicized gut is passed under the veins by an aneurysm-needle. The threads are separated one inch, tied tightly, and the ends are left long. The veins between the ligatures are excised. The two gut ligaures are tied together and cut. This shortens the cord. The scrotum is sewed up with silkworm-gut, a small drainage-tube being used for twenty-four hours. Healing is complete in one week.

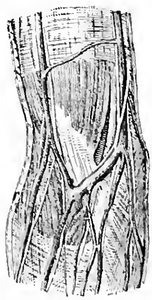
Bloodgood, of Johns Hopkins Hospital, points out that it is well to avoid dividing the genital branch of the genito-crural nerve which supplies the cremaster muscle. If this nerve should be divided, the cremaster will become lax and return of the varicocele will be favored. Bloodgood makes the incision over the external ring, draws the veins up and resects them. A wound so placed heals more certainly and promptly than does a wound of the scrotum.

Subcutaneous Ligature for Varicocele.—In this operation employ every antiseptic precaution. The patient stands, and the operator, sitting in front of him, holds the

veins in a fold of skin away from the vas deferens by means of the thumb and index-finger of the left hand. A large straight needle carrying a double piece of strong silk is passed entirely through the scrotum, between the veins and the vas. The needle is again inserted at the puncture from which it emerged, is carried around under the skin and in front of the veins, and emerges at its original point of entry. The veins are thus surrounded by the silk. The patient, who now lies down, is placed under the first stage of ether, and the double ligatures are separated as far as possible from each other, tied, and cut off, the knots slipping in through the puncture. This operation presents certain dangers. The veins may be wounded and the vas or other structures may be included. In an operation it is always best to be able to see what we are doing; and the open operation, being safe, is preferred to the subcutaneous.

Phlebotomy, or Venesection.—The instrument used in venesection is a lancet or bistoury. A fillet or tape, an antiseptic pad, and a bandage are required. A stick should be at hand for the patient to grasp.

Operation.—The patient sits on a chair "with the arm abducted, extended, and inclined outward" (Barker). The parts are asepticized and a tape is tied around the arm just above the elbow. The surgeon stands to the right of the arm, holds the elbow with his left hand, and puts his thumb upon the vein below the intended point of puncture. The patient grasps a stick firmly and works his fingers to swell the veins. Either the median cephalic or the median basilic may be opened (Figs. 96, 97). The median basilic is the more distinct, and is the vein usually selected. In opening it do not go too deep, as nothing but the bicipital fascia separates it from the brachial artery. The median cephalic may be selected (we thus avoid endangering the brachial artery); under this vein lies the external cutaneous nerve (Fig. 96). Steady the vein with the thumb and open it by transfixion, making an oblique cut which divides two-



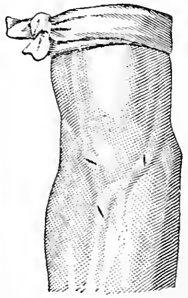


FIG. 96.—Superficial veins in front of elbow. FIG. 97.—Incisions for venesection. (Bernard and Huette.)

thirds of it. Remove the thumb and allow bleeding to go on, instructing the patient to work his fingers. When faintness begins remove the fillet, put an antiseptic pad over the puncture, apply a spiral reversed bandage of the hand and arm and a figure-of-8 bandage of the elbow, and place the arm in a sling for several days.

Transfusion of Blood.—This operation has been a recognized procedure since 1824, though it has been known since 1492, when transfusion was employed in the case of Pope Innocent VIII. Its chief use was in severe hemorrhage, especially post partum, in which it served to replace the blood lost and supplied something for the heart to contract upon until new blood formed. Senn insists that the operation has proved an absolute failure. It does not prevent death from hemorrhage, and the transferred blood-elements do not retain vitality. Von Bergmann showed that after severe hemorrhage we do not need to inject nutritive elements, but do need to restore the greatly diminished intracardiac and intravascular pressure. At the present day a saline fluid is infused in preference to transfusing blood. In fact, the operation of transfusion has become all but extinct. It exposes the patient to the danger of embolism and infection, its employment requires material and instruments often difficult to obtain in an emergency, and it has no single element of value beyond that secured by the use of salt solution.

Intravenous infusion of saline fluid is used after severe hemorrhage, in shock, in diabetic coma, in post-operative suppression of urine, and occasionally in sepsis. After a hemorrhage its beneficial effects are often prompt and obvious. This saline fluid increases the arterial tension, gives the heart enough matter to contract upon, and so restores the activity of the circulation, and does not destroy the red corpuscles as plain water would do. We may use a simple apparatus consisting of a rubber tube, a funnel, and an aspirating-needle. Some employ an Aveling syringe, and others Collins's apparatus (Fig. 98). The last-named instrument can be used without any danger of air entering with the fluids. Spencer's instrument (Fig. 99) is convenient and useful. Normal salt solution is the fluid usually employed, of a strength of 0.6 per cent. (a heaping teaspoonful of common salt to a quart of warm boiled water). Some surgeons employ an artificial serum which contains 50 grains of chlorid of sodium, 3 grains of chlorid of potassium, 25 grains of sulphate and 25 grains of carbonate of sodium, and

2 grains of phosphate of sodium in a quart of boiled water. Szumann's solution consists of 6 parts of common salt, 1 part of sodium carbonate, and 1000 parts of water. The following solution is used by Locke and Hare: calcium chlorid, 25 gm.; potassium chlorid, 1 gm.; sodium chlorid, 9 gm.; sterile water sufficient to make 1 liter. One bottle of the commercial fluid when diluted to 1 liter gives a solution of the above composition. The results from artificial serum containing many elements are no better than from

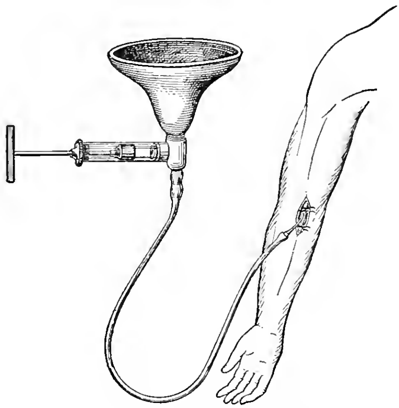


FIG. 98.—Intravenous injection of saline fluid.

normal salt solution. Whatever fluid is used, it should be at a temperature of 105° F. or over as it enters the vein. The stimulant effect of the heat is of great value. The fluid must not be allowed to cool; and a nurse gives constant attention to the temperature of the fluid in the reservoir. This degree of heat will not damage the corpuscles; in fact, Dawbarn has used saline fluid at a temperature of 118° F. without doing damage to corpuscles and with great benefit to the patient. From ½ pint to 2 pints or even more are slowly injected, the condition of the patient determining the amount given. In one case of violent hemorrhage the author used over 2 quarts. In order to infuse this fluid, tie a fillet well above the elbow, and expose by dissection the median basilic vein, or the basilic vein in the portion of its course where it is superficial to the deep fascia. Tie the vein. Incise it above the ligature, insert a fine cannula, and hold the cannula firmly in the lumen by tightening a second ligature (Fig. 98). Remove the fillet. Slowly and gradually introduce the fluid,

carefully watching the pulse. Occupy at least ten minutes in introducing a pint, except in a very desperate case of hemorrhage, when it may be given more rapidly. When the tension of the pulse returns withdraw the cannula, tie the second ligature tightly, sew up the wound, and dress it aseptically.

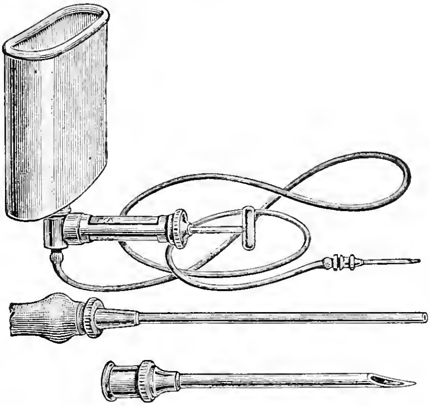


Fig. 99.—Spencer's apparatus for the infusion of saline fluid into a vein. The cannula can be plunged directly into the vessel without preliminary incision.

In very severe operations an assistant should conduct the infusion while the surgeon is operating. It may be necessary to repeat the operation if the circulation fails again. The infusion of a very large amount of saline fluid may do harm. It may embarrass the heart and may lead to edema of the lungs or brain.

Arterial Transfusion and Infusion of Saline Fluid in Arteries.—Hueter preferred the arterial method of transfusion, in order to send the blood more gradually to the heart, and thus prevent sudden disturbance of the circulation. A little air in an artery will do no harm, and the danger of venous embolism is avoided. Saline fluid can be infused into an artery. The radial artery is exposed and surrounded by three ligatures, and the thread toward the heart is at once tied. The distal ligature is slightly tightened to cut off anastomotic blood-supply. The artery is cut transversely half through; the syringe is inserted, pointed toward the periphery, and fastened by the third ligature; the second ligature is loosened and the blood is injected. On finishing, the peripheral thread is tied tightly and that portion of the artery which held the cannula is excised. Dawbarn puts a hypodermatic needle into the radial artery and injects saline fluid.

Hemophilia, or Hemorrhagic Diathesis.—The term hemophilia expresses the existence in an individual of a tendency to profuse or even uncontrollable hemorrhage spontaneously or as a result of some very trivial injury.

Hemorrhage may take place from mucous or serous membranes or from wounds of the cutaneous surface, into tissue, into organs, under the scalp, or into the external genitals. In a hemophiliac, if a cut is made, the hemorrhage from the larger vessels is easily arrested, but capillary oozing continues.

The condition is far more common in males than in females, and if it exists in a female, which it rarely does, it is not usually provocative of dangerous hemorrhage. The disease is transmitted by heredity. It is transmitted by a mother, who is usually free from the disease, but whose father had it, to a son, and the son bleeds dangerously from slight causes. The existence of the tendency is rarely suspected until the first dentition, and possibly not till puberty; "70 per cent. of cases appear before the fifth year."[1] The discovery of the existence of such a condition may not be made until a tooth is pulled, and extraction is followed by persistent bleeding. It is alleged that the tendency may disappear in middle life.

The cause of the condition is unknown. It has been assumed that there is a condition of the blood which prevents coagulation, but the blood of a hemophiliac coagulates outside of the body as well as any other blood. Furthermore, Agnew had a case in which hemophilia was limited to the head and neck, and there have been cases in which the bleeding occurred from one kidney. Some maintain that there is structural defect in the capillaries. In a case in the Jefferson Medical College Hospital in which it was absolutely necessary to amputate a finger because of a crush, a careful study of the vessels of the finger by Dr. Coplin failed to show any disease of the blood-vessels. A surgeon must be on the lookout for this condition, and should inquire for it before deciding to do an operation. If it exists, only an operation of imperative necessity should be undertaken.

A child who is "a bleeder" must be unceasingly watched and guarded. A tendency to profuse oozing exists in leukemia because of the condition of the blood, but this is not hemophilia. A tendency to oozing also exists during jaundice.

Treatment.—The oozing is difficult and often impossible to control. The internal administration of such drugs as

[1] R. C. Cabot, in *International Text-book of Surgery.*

ergot, gallic acid, and acetate of lead is useless. It is claimed that chlorid of calcium internally is of service. The local use of astringents is of no avail. Prolonged elevation may in rare cases succeed. In the case in the Jefferson Medical College Hospital the bleeding was arrested, after numerous expedients failed, by compression and hot water. Nurses sat by the bed for several days, constantly compressed the wound with gauze pads soaked in hot water, and changed the pads as soon as they cooled. The local use of Carnot's solution of gelatin has saved several cases from death. It has been advised to take some blood from a healthy man and put it in the cut, in the hope that a firm clot will form.

3. Ligation of Arteries in Continuity.

The **instruments** used in this operation are two scalpels (one small, one medium), two dissecting-forceps, several

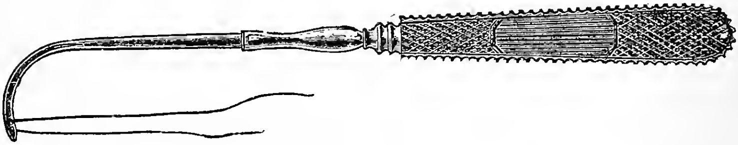


Fig. 100.—Aneurysm-needle of Saviard.

hemostatic forceps, toothed forceps, blunt hooks or broad metal retractors, an Allis dissector, an aneurysm-needle, for superficial arteries the instrument of Saviard (Fig. 100), for deep vessels the needle of Dupuytren (Fig. 101), ligatures of catgut, of chromicized gut, or of silk, curved needles and a needle-holder, sutures of silkworm-gut, and the reflector or electric forehead-lamp for deep vessels.

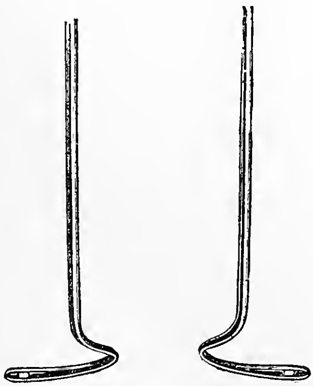


Fig. 101.—Dupuytren's aneurysm-needles.

The **position** in which the patient is placed varies according to the vessel to be ligated, though the body is supine except when ligation is to be performed on the gluteal, sciatic, or popliteal artery. The operator, as a rule, stands upon the affected side, cutting from above downward on the right side and from below upward on the left side.

Operation.—Accurately determine the *line* of the artery,

and make an incision at a slight angle to this line, avoiding subcutaneous veins, and holding the scalpel like a fiddle-bow or a dinner-knife while cutting the superficial parts, and like a pen while incising the deeper parts. On reaching the deep fascia make out the required muscular gap by the eye and finger, so moving the extremity as to bring individual muscles into action. Treves cautions us not to depend upon the yellow line of fat, which often cannot be seen in emaciated people or when an Esmarch bandage is employed; nor upon the white line due to attachment to the fascia of an intermuscular septum. In opening the deep portion of the wound relax the bounding muscles by altering the posture. Open a muscular interspace with a sharp knife, not with a dissector. Make the depths of the wound as long as the superficial incision. Do not tear structures apart with a grooved director; cut them. Arrest hemorrhage as it occurs. Try to find the situation of the artery with the finger. Pulsation is present, but it may be very feeble and hard to detect. The artery feels like a very thin rubber tube; it is compressible, though not so easily as a vein, and when compressed feels like a flat band which is thinner in the center than at the edges (Treves). A nerve feels like a hard round cord. The veins are soft, larger than their related arteries, and so very compressible that they can scarcely be felt when pressed upon, and compression causes distal distention. If the wound can be seen into clearly, it will be noted, as Treves asserts, that "the nerves stand out as clear, rounded, white cords; that the veins are of a purple color and of somewhat uneven and wavy contour; that the artery is regular in outline and of a pale-pink or pinkish-yellow tint, the large vessels being of lighter color than the small." All the arteries of the upper extremity and all the arteries below the knee are accompanied by two veins, known as "venæ comites." The arteries of the head and neck, except the lingual, have each a single attending vein; the lingual has venæ comites. Most of the smaller arteries of the trunk (pudic, internal mammary, etc.) have venæ comites. These companion veins may lie on each side of the artery or in front and back of it, and they communicate with one another by transverse branches crossing the artery. On reaching the sheath pick up this structure with toothed forceps so as to make a transverse fold, and thus avoid catching the artery or vein; lift the fold to see that it is free, and open the sheath by cutting toward the edge of the forceps with a scalpel held obliquely with its back toward the vessel, thus

making a small longitudinal incision (Pl. 2, Figs. 1, 2). Hold the edge of the incised sheath with the forceps; pass a metal dissector under the vessel and from the forceps; this clears one-half of the vessel. Grasp the other edge of the sheath and pass the blunt dissector all the way around the vessel. Pass an aneurysm-needle under the cleared vessel, away from the forceps holding the sheath and away from the vessel's most dangerous neighbor. Thread the needle and withdraw it. If venæ comites are in the way, try to separate them; but if this proves difficult, include them in the ligature. In small vessels always include them if they are in the way, as this saves trouble. If, in passing the needle, a large vein is severely wounded (such as the femoral), Jacobson advises the employment of digital pressure in the lower portion of the wound while the artery is being tied on a level above or below that of the vein-injury, and after ligation the maintenance of pressure on the wound for a couple of days. A slight puncture in a vein merely requires a lateral ligature. A small longitudinal cut can be closed with Lembert sutures of fine silk. After getting a ligature under an artery press for a moment upon the artery over the ligature, which is held taut; this pressure will arrest pulsation below if the ligature is around the main artery and there is not a double vessel. Tie the thread at right angles to the vessel with a reef-knot (Fig. 102), rupturing the internal and middle coats. As the ligature is tightened place the extended index-fingers along the ligature up to the artery (Pl. 2, Fig. 3), using the middle joints as the fulcrum of a lever by placing them against each other.

Ballance and Edmunds have recently claimed, as Scarpa and Sir Philip Crampton did long since, that it is not necessary to divide the internal and middle coats to insure obliteration. If this claim be true, the danger of secondary hemorrhage can be greatly lessened. Holmes, however,

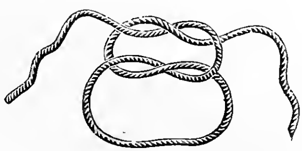


FIG. 102.—Reef-knot.

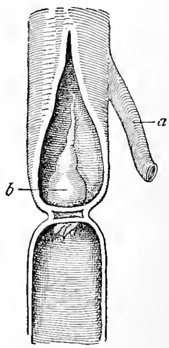
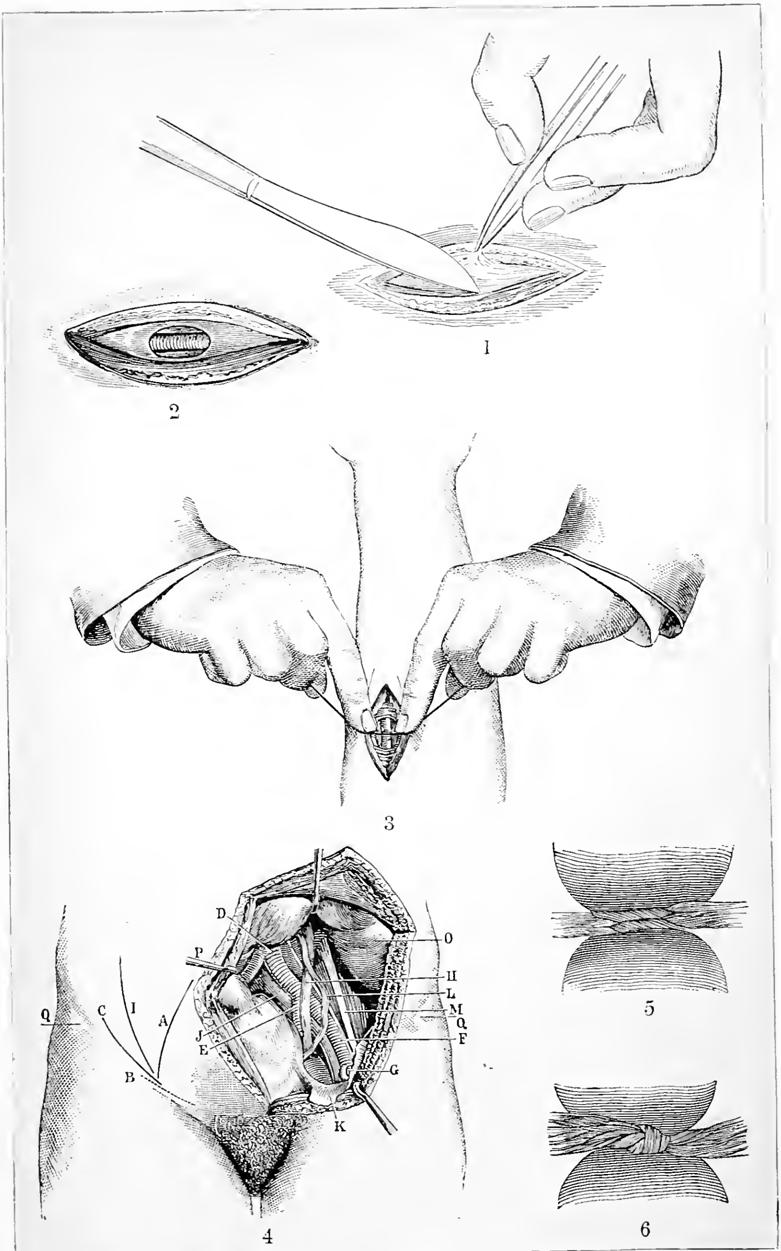


FIG. 103.—Diagram showing the action of the ligature.



1. Opening the Sheath for Ligation of an Artery (Guerin). 2. Sheath of Artery Open (Guerin). 3. Tightening the Knot in Ligation (Guerin). 4. Anatomy of the Iliac Arteries, and showing the lines of incision for their ligation: 1, Abernethy's incision (Guerin). 5, 6. Ballance and Edmund's Stay-knots.

thinks the older method the more certain of the two. Ballance and Edmunds use floss silk as a ligature-material, because it is soft, broad, and flat, and they surround the artery with a double ligature. Ballance and Edmunds thus describe the application of the stay-knot: "the best way of tying two ligatures is to make on each separately, and in the same way, the first hitch of a reef-knot, and to tighten each separately so that the loop lies in contact with the vessel without constricting it. Then taking the ends on one side together in one hand and the two ends on the other side in the other hand, constrict the vessel sufficiently to occlude it, and finally complete the reef-knot. The simplest way of completing the knot is to treat the two ends in each hand as a single thread and to tie as if completing a single reef-knot." This knot is shown in Pl. 2, Figs. 5, 6. The stay-knot applied by this method is of great value if a vessel be atheromatous.

The chief dangers after ligation are secondary hemorrhage and gangrene. Rigid asepsis usually prevents the first; rest, elevation, and heat antagonize the second.

Radial Artery.—The *line* of the radial artery is from the middle of the front of the elbow-joint to the ulnar side of the styloid process of the radius. The *line* in the tabatière is from the apex of the styloid process to the posterior angle of the first interosseous space.

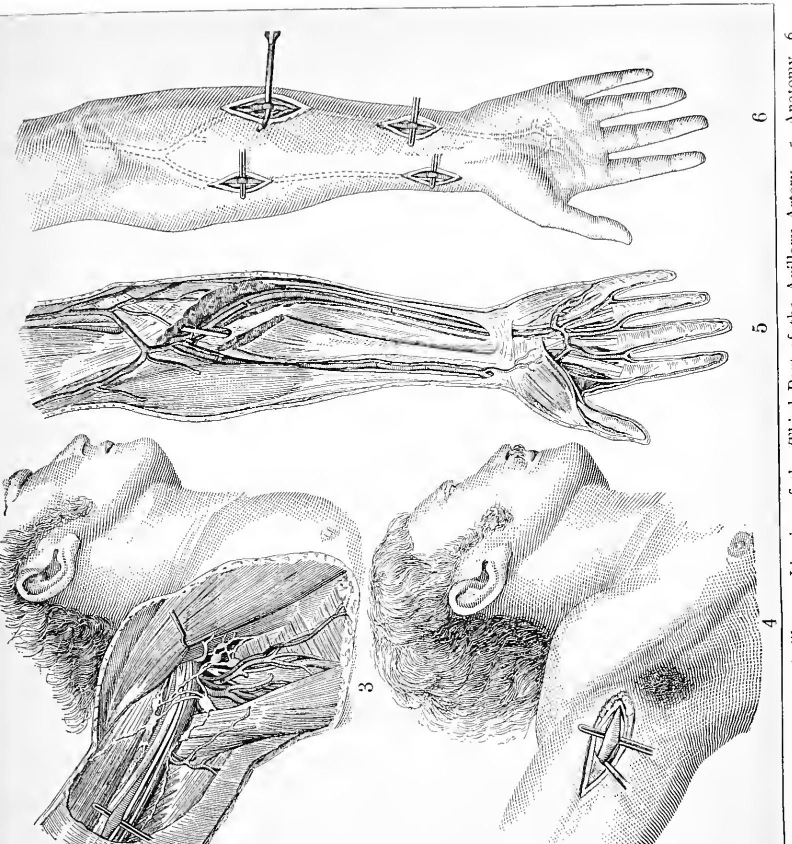
Anatomy (Pl. 3, Fig. 5).—The radial artery, though smaller than the ulnar, is the direct continuation of the brachial. It arises from the bifurcation of the brachial half an inch below the bend of the elbow, runs down the radial side of the forearm to the front of the styloid process of the radius, passes beneath the extensor muscles of the first metacarpal bone and of the first phalanx of the thumb, and over the carpus to the first interosseous space. It is crossed by the tendon of the extensor secundi internodii pollicis, enters into the palm between the heads of the first dorsal interosseous muscle, and forms the deep palmar arch. The artery in the upper two-thirds of its course is somewhat overlaid by the supinator longus muscle; in the lower one-third of the forearm it is superficial. In the upper third of the forearm it lies between the supinator longus on the outside and the pronator radii teres on the inside; in the lower two-thirds of the forearm it lies between the supinator longus on the outside and the flexor carpi radialis on the inside. Two venæ comites attend the vessel. The radial nerve is to the outer, or radial, side of the artery, well removed from the

artery in the upper third, nearer to the artery in the middle third, far external to the artery in the lower third, the nerve at this point passing beneath the supinator longus muscle. The radial artery, from above downward, rests upon the biceps tendon, the supinator brevis, the flexor sublimis, the pronator radii teres, the flexor longus pollicis, the pronator quadratus muscles, and the radius. The best guide to the radial artery in the forearm is the outer edge of the flexor carpi radialis muscle or the inner edge of the supinator longus muscle.

The tabatière anatomique of Cloquet, or the anatomical snuff-box, is a triangle whose base is the lower edge of the posterior annular ligament, the ulnar side being formed by the extensor secundi internodii pollicis tendon, the radial side by the extensor ossis metacarpi and the extensor primi internodii pollicis tendons; the floor consists of the trapezium, scaphoid, their dorsal ligaments, and the base of the first metacarpal bone.

Operations.—*Ligation in the tabatière* is a dissecting-room operation of but little practical use. The patient is placed in a recumbent position, the arm is abducted, and the forearm is placed midway between pronation and supination (Barker). The surgeon stands upon the side operated upon. An incision two inches in length is made along the radial border of the extensor secundi internodii pollicis muscle. The skin and superficial fascia are cut and some venous branches are divided. The deep fascia is incised and the vessel is easily found and tied before it passes between the heads of the first dorsal interosseus muscle (Barker).

Ligation of the Lower Third.—In this operation (Pl. 3, Fig. 6) the patient is placed supine, the arm is abducted, the forearm is supinated, is rested upon a table, and is held by an assistant. The surgeon stands on the side operated upon, and cuts from above downward on the right forearm and from below upward on the left forearm. The line of the vessel should be determined, and may be indicated with iodin or anilin. An incision one and a half inches long is made at a slight angle to this line and midway between the supinator longus and the flexor carpi radialis muscles, which incision must not extend below the level of the tuberosity of the scaphoid bone. In the superficial fascia watch for the superficial radial vein, and if it comes into view push it aside. Incise the superficial fascia and locate each guide-tendon. Open the deep fascia in the length of the first cut; try to separate the veins, but if they strongly adhere include



1, Anatomy, 2, Ligation, of the Brachial Artery. 3, Anatomy of the Axilla. 4, Ligation of the Third Part of the Axillary Artery. 5, Anatomy, 6, Ligation, of the Radial and Ulnar Arteries. (From Bernard.)

them in the ligature. There is no special fascial sheath. The radial nerve will not be seen, but a division of the anterior cutaneous nerve is frequently found in relation with the vessel. The needle can be passed in either direction. A high origin of the superficialis volæ artery is confusing.

Ligation of the Middle Third.—In this operation the position of the patient should be the same as in the preceding. A two-inch incision is made. Veins of the subcutaneous tissues are avoided. Lying upon the deep fascia is the anterior division of the musculocutaneous nerve. Open the fascia: find the inner edge of the supinator longus muscle and draw it outward, flexing the elbow partly if necessary. Be sure not to cut external to this muscle. Find the vessel where it is bound down by connective tissue to the pronator radii teres muscle, separate the veins, and pass the ligature from without inward. The nerve is external.

Ligation of the Upper Third (Pl. 3, Fig. 6).—In this operation the incision is as described above, only higher up. The artery is between the supinator longus and the pronator radii teres, which muscles are at once differentiated by the different direction of their fibers. The artery is usually covered by the supinator longus muscle, which must be retracted externally. The nerve is not seen. The ligature may be passed in either direction.

Ulnar Artery.—No one *line* will overlie the entire ulnar artery. The line of the upper third runs from the middle of the front of the elbow-joint to the point of junction of the upper and middle thirds of the ulna. The line of the lower two-thirds runs from the tip of the internal condyle of the humerus to the radial side of the pisiform bone (Pl. 3, Figs. 5, 6).

Anatomy (Pl. 3, Fig. 5).—The ulnar artery arises from the brachial bifurcation and runs obliquely inward under the median nerve and a group of muscles from the internal condyle; it turns down the arm, being covered in the middle third of its course by the flexor carpi ulnaris muscle. In the lower third it is superficial, between the tendons of the flexor carpi ulnaris on the inside and the flexor sublimis digitorum on the outside, the vessel being a little overlapped by the flexor carpi ulnaris. This vessel rests first upon the brachialis anticus muscle, next upon the flexor profundus, to which it is bound by a distinct process of fascia, and next upon the annular ligament, which structure it crosses to become the superficial palmar arch. Two venæ comites attend the vessel. In the upper third the nerve is well internal, but in the lower

two-thirds the nerve lies near the artery and to its ulnar side. The guide is the outer edge of the flexor carpi ulnaris.

Operations (Pl. 3, Fig. 6).—*Ligation of the Lower Third.*—The position in this operation is the same as for ligation of the radial artery. Make a two-inch incision to the radial side of the tendon of the flexor carpi ulnaris, which incision should not be taken lower than a point one inch above the pisiform bone. Avoid the superficial ulnar vein in the subcutaneous tissue. Open the deep fascia, find the tendon of the flexor carpi ulnaris, flex the wrist and draw the tendon inward, open a second layer of fascia, clear the vessel, separate the veins, and pass the ligature from within outward to avoid the nerve. On the artery is the palmar cutaneous branch of the ulnar nerve, and this branch must not be included in the ligature.

Ligation of the Middle Third (Pl. 3, Fig. 6).—In this operation the position is the same as in the preceding one, the incision being three inches long. Avoid the anterior ulnar vein and the branches of the internal cutaneous nerve in the superficial fascia. Open the deep fascia a little external to the superficial cut (Treves). Find the space between the flexor carpi ulnaris and the superficial flexor, feeling with the index-finger, and when the space is discovered flex the wrist, retract the flexor carpi ulnaris inward and the flexor sublimis digitorum outward, open the fascia, find the ulnar nerve, look external to it for the artery, clear the vessel, separate the venæ comites, and pass the needle from within outward. The ulnar artery should not be ligated in continuity in the upper third of its course.

Brachial Artery.—The *line* of the brachial artery is from the junction of the anterior and middle thirds of the outlet of the axilla, the arm being abducted and the forearm supinated, to the middle of the front of the elbow-joint.

Anatomy (Pl. 3, Fig. 1).—The brachial artery is the prolongation of the axillary, and extends from the lower edge of the teres major muscle to half an inch below the bend of the elbow, where it divides into the radial and ulnar arteries. It lies first to the inner side of the arm, but passes to the front of the elbow. It is crossed by no muscle, and is, in fact, superficial, barring its being somewhat overlaid in part of its course by the edge of the biceps muscle. The median nerve is external above, crosses over the vessel about the middle of the arm, and reaches the inner side of the artery. The coracobrachialis and biceps muscles are external, and both often overlap the vessel. The ulnar nerve is internal

above, and the median nerve is internal below the middle. The basilic vein is to the inner side of the artery, being outside the deep fascia to near the middle of the arm, at which point it pierces it. The artery above is separated from the long head of the triceps by the musculospiral nerve and superior profunda artery and vein; it rests from above down on the inner head of the triceps, the coracobrachialis, and the brachialis anticus muscles. The artery is covered by skin, by superficial fascia, and by deep fascia. The internal cutaneous nerve lies in front of the artery, upon the deep fascia, until it pierces the fascia along with the basilic vein. The artery has venæ comites, and in its upper half has also the basilic vein to its inner side. The guide to the brachial is the inner edge of the biceps muscle. Just in front of the elbow-joint the artery lies in a triangle, the base of which is formed by an ,imaginary transverse line above the condyles, and the apex by the junction of the pronator radii teres and the supinator longus muscles. The outer line is the supinator longus, the inner line is the pronator radii teres, and the floor is formed by the brachialis anticus and the supinator brevis muscles. From within outward the triangle contains the median nerve, brachial artery, tendon of the biceps, anastomosis of the superior profunda and radial recurrent arteries, and the musculospiral nerve.

Operations.—*Ligation at the Bend of the Elbow.*—In this operation (Pl. 3, Fig. 2) the patient is placed supine, the arm is moderately abducted and extended, and is allowed to lie upon its posterior aspect. The forearm is supinated. The surgeon stands upon the side operated upon, and cuts from above downward on the right side and from below upward on the left side. The tendon of the biceps and the median basilic vein must be accurately located. An incision is made parallel with the inner edge of the biceps tendon and two inches in length, the center of this cut being in the crease of the elbow. On exposing the median basilic vein, retract it downward and inward, open the bicipital fascia, clear the artery of fat, separate the venæ comites, and pass the ligature from within outward to avoid the median nerve. The above operation is not frequently performed.

Ligation in the Middle of the Arm.—In this operation the patient is placed supine, the arm is abducted, and the forearm is supinated. An assistant holds the forearm, but the arm should not rest upon the table, because, if it be allowed to do so, the inner head of the triceps will be forced forward and may overlie the artery, and thus complicate the

operation. Locate the inner edge of the biceps, which is the guide. Make an incision three inches long in the line of the artery. Incise the skin and fascia, flex the elbow slightly, retract the biceps outward, feel for the artery, open the sheath, separate its venæ comites, and, having located the median nerve, pass the ligature from it. In the middle of the arm the nerve is in front of the vessel, above the middle it is external to it, and below the middle it is internal to it. High up the arm the inner edge of the coracobrachialis is the guide, rather than the biceps. Above the middle of the arm the basilic vein is beneath the deep fascia and passes along by the inner side of the artery; hence, high up, the artery has three companion veins, the venæ comites and the basilic vein, and there is seen the ulnar nerve to the inside of the artery.

Axillary Artery.—To determine the *line* of the axillary artery place the arm at a right angle to the body, with the patient supine, and lay down a line from the middle of the clavicle to the humerus near the inner border of the coracobrachialis. The line of the third portion can be approximated by projecting the line of the brachial upward.

Anatomy (Pl. 3, Fig. 3; Pl. 4, Fig. 1).—The axillary artery is the continuation of the subclavian, and runs from the lower margin of the first rib to the inferior border of the teres major muscle. It is divided into three portions by the pectoralis minor muscle. The first portion is above, the second portion is behind, and the third portion is below, the pectoralis minor. The position of the artery varies with the position of the limb. When the arm is parallel with the body the artery is far from the surface and forms a curve whose convexity is upward and outward. When the arm is at a right angle to the body the vessel is nearer the surface and straight. When the arm is raised above a right angle the artery comes near the surface and forms a curve with the convexity downward.

The first portion of the axillary artery is occasionally ligated. It lies upon the first intercostal muscle and the first serration of the great serratus muscle, and has behind it the posterior thoracic nerve; the brachial plexus is external and posterior to the vessel; on its inner side is the axillary vein; in front of it are the clavicle, the great pectoral muscle, the subclavius muscle, the costocoracoid membrane, the cephalic and acromiothoracic veins, and the external anterior thoracic nerve. The branches of the first part of the axillary artery are the superior thoracic and the acromio-

thoracic. The second part of the artery is not ligated. The brachial plexus surrounds the second portion. The third part is covered in front, above, by the great pectoral, but is covered below by skin and fascia; behind, it has the tendon of the subscapularis, the latissimus dorsi, and the teres major muscles; the coracobrachialis is on the outer side; the axillary vein is on the inner side. It is important to remember that there may be three veins, one external and two internal. The axillary vein is formed by the venæ comites of the brachial artery joining, and this new vein effecting a junction with the basilic vein. The median nerve lies upon the axillary artery in the upper part of the third portion of the vessel's course, and passes to the outer side. The musculocutaneous nerve is external, but it is only seen high up; the ulnar nerve is internal; the lesser internal and the internal cutaneous nerves are internal; the musculospiral and the circumflex nerves are behind. The branches of the third portion of the axillary artery are the subscapular and the anterior and posterior circumflex.

Operations.—*Ligation of the Third Portion* (Pl. 3, Fig. 4).—The position of the patient should be supine, with the shoulders raised and the arm abducted to a right angle. The surgeon stands between the patient's arm and side, with his back toward the subject's feet. An incision is made three inches in length. It begins half-way up the axilla opposite to the head of the humerus, and is taken downward parallel to the lower edge of the great pectoral muscle and crosses the junction of the anterior and middle thirds of the outlet of the axilla. The integuments and fascia are incised. The vein or veins will be prominent to the inner side and may overlie the vessel. To the inner side with the veins are the ulnar and internal cutaneous nerves. The median nerve is upon, and the external cutaneous is to the outer side of, the artery. Feel for the pulsations of the artery, find the median nerve, and draw it outward, draw the nerves and veins which lie to the inner side inward, clear the artery from the venæ comites, and pass the ligature from within outward. Apply the ligature well below the circumflex branches.

Ligation of the First Part.—This operation (Pl. 4, Fig. 2) was first performed in 1815 by Chamberlaine of Jamaica. The patient is placed supine, the upper part of the body being raised, a sand-pillow being placed between the scapulæ to insure carrying back of the point of the shoulder, and the arm being brought down along the side. In operating on the left side the surgeon stands on the outer side of the left

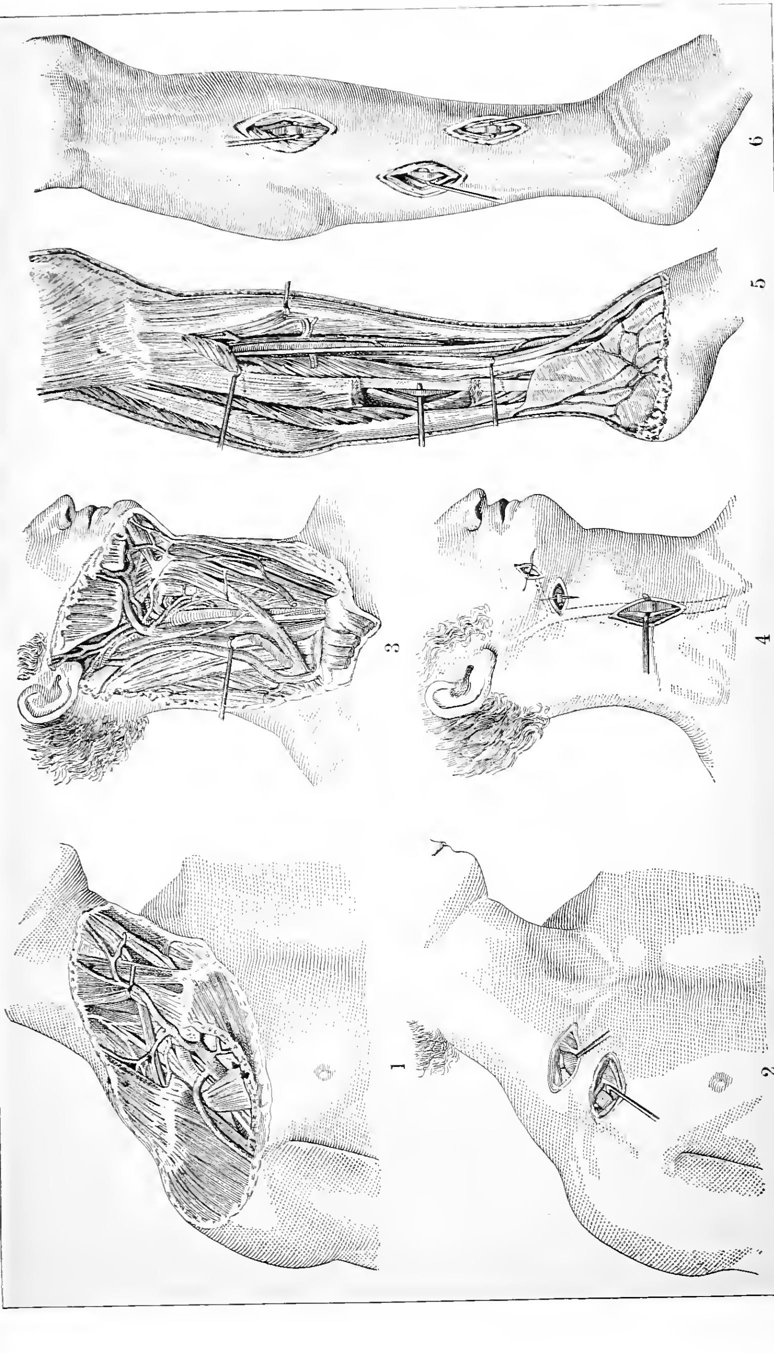
arm; in operating on the right side he stands to the right of the subject's head and leans over his shoulder. The incision, which is slightly curved downward, begins external to the sternoclavicular joint and ends internal to the margin of the deltoid, thus avoiding the cephalic vein. The incision is half an inch below the clavicle. Incise the skin, the platysma myoides muscle, and the deep fascia. In the outer angle of the wound watch out for the acromiothoracic artery and the cephalic vein. Incise the pectoralis major; draw the pectoralis minor downward; retract the lower margin of the wound, cut through the costocoracoid membrane close to the coracoid process and the upper border of the lesser pectoral muscle. Bring the arm to the side so as to relax the structures. Find the brachial plexus, feel for the artery internal to it, clear the vessel, draw the vein internally, and pass the needle from within outward. This avoids the dangerous neighbor, which is the axillary vein. This operation is difficult, dangerous, and unusual, and in its performance the axillary vein, which has a close attachment to the costo-coracoid membrane, is apt to be torn.

Subclavian Artery.—There is no *line* for this vessel.

Anatomy (Pl. 4, Fig. 1).—The subclavian artery of the right side arises from the innominate; that of the left side, from the arch of the aorta. The subclavian is divided into three parts. The first part runs from the origin of the vessel to the inner border of the scalenus anticus muscle; the second part lies behind the scalenus anticus muscle; and the third part runs from the outer edge of the muscle to the lower border of the first rib.

At the present day the first and second portions are rarely ligated. The third portion is contained in the subclavian triangle (Fig. 104), and is superficial. It rises, as a rule, to half an inch above the clavicle. The subclavian vein is below the artery, being separated from it by the scalenus anticus muscle. The brachial plexus is above and external to the artery. The vessel rests upon the first rib, and behind it is the scalenus medius muscle. The suprascapular and transversalis colli arteries and veins and branches of the cervical plexus of nerves lie in front of the artery, and the external jugular vein crosses it at its inner side. The third portion gives off no branches.

Ligation of the Third Part.—This operation (Pl. 4, Fig. 2) was first successfully performed in 1817 by Post of New York. The patient is placed upon his back, the shoulders are raised, the head is extended and turned toward the opposite side, the



1, Anatomy, 2, Ligation, of the Subclavian Artery and First Part of the Axillary Artery. 3, Anatomy of the Neck. 4, Ligation of the Carotid, Lingual, and Facial Arteries. 5, Anatomy, 6, Ligation, of the Anterior Tibial and Peroneal Arteries. (From Bernard.)

arm is pulled down and held by pushing the forearm under the patient's back (Treves). This pulls down the clavicle, thus increasing the size of the subclavian triangle. The operator stands facing the shoulder, with his back toward the patient's feet. The skin over the subclavian triangle, at a point half an inch above the clavicle, is drawn down until it overlies the bone and is incised. This maneuver enables the surgeon to avoid the external jugular vein and to make an incision in the skin half an inch above the collar-bone. The incision reaches from the anterior edge of the trapezius to the posterior border of the sternocleidomastoid (Pl. 4, Fig. 2), and is about three inches long. By this incision are divided the skin, the superficial fascia, the platysma myoides, the vein running from the cephalic to the external jugular, and some superficial nerves. The deep fascia is opened. The external jugular vein is drawn into the inner angle of the wound, and is not divided unnecessarily; if forced to divide the vein, tie with two ligatures and cut between them. The surgeon seeks to find the outer edge of the anterior scalene muscle, and runs the finger down along it to the tubercle on the first rib. The posterior belly of the omohyoid muscle is drawn upward by an assistant. The surgeon with a finger on the tubercle recalls the facts that the vein is in front of the finger and the artery is behind it, and that the subclavian vein is on a lower plane than the artery. The artery is felt beating as it lies upon the rib. The artery is cleared and the lower cord of the brachial plexus is exposed. The vein must be guarded with the finger and the needle is passed from above downward, as the plexus, which is in more danger than the vein, is to be avoided. In this operation the transversalis colli and suprascapular arteries must not be cut, as they are necessary to the future anastomotic circulation. If the field of operation is too small, the trapezius or sternocleidomastoid, or both, should be incised transversely.

The **vertebral artery** was first successfully ligated by Smyth of New Orleans.

Anatomy.—This vessel is the largest branch of the subclavian, and is the first branch coming from the first portion of the subclavian. The vertebral artery ascends and enters the foramen in the transverse process of the sixth cervical vertebra (in rare cases the fifth or the seventh), and ascends through foramina in the cervical vertebræ, passes behind the articular process of the atlas and over the posterior arch of this first vertebra, pierces the posterior occipito-atloid liga-

ment, and enters the skull by way of the foramen magnum (see Gray). It joins its fellow of the opposite side to form the basilar artery. At its point of origin the vertebral artery has in front of it the internal jugular vein and inferior thyroid artery. Gray says that near the spine it lies between the longus colli and scalenus anticus muscles, with the thoracic duct to the left and in front.

Ligation.—The position of the patient is the same as for ligation of the carotid artery. Make an incision three inches in length along the posterior edge of the sterno-cleidomastoid muscle. This incision reaches the clavicle. In dividing the skin and superficial fascia watch for the external jugular vein and retract it inward. Divide the deep fascia. Retract the strenocleidomastoid muscle inward. Open the space between the longus colli and scalenus anticus muscles, find the artery, clear it, and pass the needle from the inner side. Jacobson tells us to remember that the phrenic nerve lies on the scalene muscle, the pleura is internal, the internal jugular, inferior thyroid, and vertebral veins are over the vessel, and the thoracic duct on the left side crosses it from within outward.

The Inferior Thyroid Artery.—Anatomy.—The inferior thyroid artery is a branch of the thyroid axis. It ascends the neck, passes back of the carotid sheath and the sympathetic nerve, and reaches the thyroid gland. The recurrent laryngeal nerve lies behind the artery. The phrenic nerve is external to the artery and near to it in the first part of its course (up to the point of origin of the ascending cervical branch). The ascending cervical branch takes origin just before the artery begins to dip behind the carotid. In front of the beginning of the inferior thyroid artery of the left side the thoracic duct crosses. The artery is ligated in the second part of its course (between its distribution and the origin of the above-named branch).

Ligation.—The position of patient and the incision are the same as for the ligation of the common carotid artery in the triangle of necessity (p. 372). After exposing the sterno-cleidomastoid muscle retract it outward, and then draw outward the common carotid artery and also the internal jugular vein. The superior thyroid artery will be found a little below the carotid tubercle. It is cleared and ligated. Treves advises ligation close to the level of the carotid, so as to avoid the recurrent laryngeal nerve.

Innominate Artery.—First successfully ligated by Smyth of New Orleans. It is an extremely fatal operation.

Anatomy.—The innominate artery arises from the beginning of the transverse portion of the arch of the aorta, passes to the back of the right sternoclavicular joint, and divides into the common carotid and subclavian vessels. It rests upon the trachea. It has upon its outer side the pleura, the right innominate vein, and the pneumogastric nerve. Upon its inner side are the remnant of the thymus gland and the beginning of the left carotid artery. In front of it are the inferior thyroid veins of the right side, the left innominate vein, the sternohyoid and sternothyroid muscles, the remnant of the thymus gland, and sometimes a branch from the right pneumogastric nerve.

Ligation.—The patient is placed supine, with the shoulders a little raised, and the head thrown back. An incision is carried from the upper margin of the sternum for three inches along the anterior margin of the sternomastoid. Another cut of the same length is made along the upper border of the clavicle to meet the first cut. Dissect up the flap of skin and fascia. Divide the sternal origin and a part of the clavicular portion of the sternocleidomastoid muscle, and cut the sternohyoid and sternothyroid muscles just above their sternal origins (Joseph Bell). Retract the inferior thyroid veins. Divide the dense leaflet of cervical fascia. Find the common carotid artery, and trace back along this vessel until the innominate comes into view. Retract the left innominate vein downward. The needle is passed from without inward to avoid the right innominate vein and right pneumogastric nerve. If the needle is kept close to the artery, the pleura and trachea will not be injured.[1]

Region of the Neck.—Anatomy.—The side of the neck is that space between the median line in front and the anterior edge of the trapezius muscle behind, which space is limited below by the clavicle and above by the body of the jaw and an imaginary line running from the angle of the jaw to the mastoid process. The sternocleidomastoid muscle divides this space into an anterior and a posterior triangle, and each of the triangles is subdivided by other structures, the anterior into four spaces and the posterior into two (Fig. 104).

Anterior Triangle.—The anterior triangle is bounded in front by the median line of the neck, behind by the anterior margin of the sternocleidomastoid muscle, and above by the body of the lower jaw and an imaginary line drawn from the angle of the jaw to the mastoid process. This space

[1] See the exceedingly clear and terse account in that excellent book, *A Manual of Surgical Operations*, by Joseph Bell.

is subdivided into four smaller triangles, namely, the inferior carotid, the superior carotid, the submaxillary, and the submental.

The *inferior carotid triangle* is called the "triangle of necessity," because the common carotid artery in this region is ligated, not from choice, but through force of necessity. It is bounded in front by the median line, above by the anterior belly of the omohyoid muscle and the hyoid bone, and below by the anterior edge of the sternomastoid muscle. The floor of this triangle is composed of the longus colli, the scalenus anticus, the rectus capitis anticus major, the sternohyoid, and sternothyroid muscles.

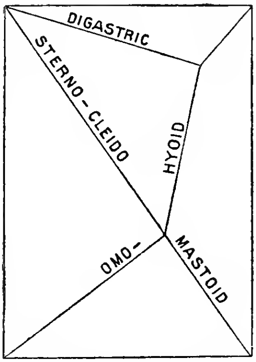


FIG. 104.—The triangles of the neck, right-sided view (after Keen): 1, submaxillary triangle; 2, "triangle of election," or superior carotid triangle; 3, submental triangle; 4, "triangle of necessity," or inferior carotid triangle; 5, occipital triangle; 6, subclavian triangle; 7, hyoid bone.

The *superior carotid triangle* is known as the "triangle of election," because, if the carotid artery must be tied, the surgeon, whenever possible, elects or chooses to tie it in this triangle. In this region the carotid is superficial, and there can be tied either the external, the internal, or the common carotid artery, as may be desired. The triangle is bounded behind by the anterior edge of the sternocleidomastoid, above by the posterior belly of the digastric, and below by the anterior belly of the omohyoid muscles. Its floor is composed of the inferior and middle constrictors of the pharynx and the thyrohyoid and hyoglossus muscles.

The *submaxillary triangle* is bounded above by the body of the jaw and an imaginary line drawn from the angle of the jaw to the mastoid process, behind by the posterior belly of the digastric muscle and the stylohyoid muscle, and in front by the anterior belly of the digastric muscle. Its floor is composed of the mylohyoid and hyoglossus muscles.

The *submental triangle* is bounded on either side by the anterior belly of one digastric muscle; its base is the hyoid bone and its floor is the mylohyoid muscle.

The *posterior triangle* is bounded in front by the posterior border of the sternocleidomastoid muscle, behind by the anterior edge of the trapezius muscle, and below by the clav-

icle. The posterior belly of the omohyoid muscle subdivides it into two smaller spaces, the occipital and subclavian triangles.

The *occipital triangle* is bounded in front by the posterior edge of the sternocleidomastoid muscle, behind by the anterior border of the trapezius muscle, and below by the posterior belly of the omohyoid muscle.

The *subclavian triangle* is bounded above by the posterior belly of the omohyoid muscle, below by the clavicle, and in front by the posterior border of the sternocleidomastoid muscle. Its floor is formed by the first rib and the first serration of the serratus magnus muscle.

Common Carotid Artery.—The *line* of the common carotid artery is from the sternoclavicular articulation to midway between the angle of the jaw and the mastoid process, the head being turned toward the opposite side.

Anatomy (Pl. 4, Fig. 3).—The right common carotid arises from the innominate opposite the sternoclavicular joint; the left common carotid arises from the arch of the aorta. In the neck the two carotids possess identical relations. The common carotid runs upward and outward from behind the sternoclavicular articulation to a level with the upper border of the thyroid cartilage, at which point it divides into the external and internal carotid. The common carotid is contained in a sheath derived from the cervical fascia. This sheath also contains, in separate compartments, the internal jugular vein on the outer side of the artery and the pneumogastric nerve between the vein and artery, but more deeply placed. The anterior edge of the sternocleidomastoid muscle lies over the artery and is a guide. Low in the neck the common carotid is deep, being covered by skin, superficial fascia, platysma, deep fascia, and the sternocleidomastoid, sternohyoid, and sternothyroid muscles. Above the omohyoid muscle the vessel is more superficial, being covered by the skin, superficial fascia, platysma, deep fascia, and the anterior edge of the sternocleidomastoid muscle. Upon the sheath (occasionally within it), above the crossing of the omohyoid muscle, lies the descendens noni nerve—the descending branch of the ninth pair of Willis (the hypoglossal). This nerve is a valuable guide to the sheath in the triangle of election.

The *sternomastoid* branch of the superior thyroid artery crosses the carotid artery a little below its bifurcation, and the superior thyroid vein also crosses it in this region; the middle thyroid vein crosses the artery near its middle, and the ante-

rior jugular vein crosses low down. The common carotid rests upon the longus colli and rectus capitis anticus major muscles, the sympathetic nerve lying between the last-named muscle and the vessel, outside the carotid sheath. The recurrent laryngeal nerve passes behind the carotid below the omohyoid muscle, and the inferior thyroid artery passes behind the carotid just above the omohyoid muscle. The common carotid is in relation internally with the trachea, thyroid gland, larynx, and pharynx. To the outer side are the pneumogastric nerve (which is on a posterior plane) and the internal jugular vein. On the left side, low down in the neck, the jugular vein often lies in front, or partly in front, of the artery. Ligation of the common carotid was first successfully performed in 1806 by Sir Astley Cooper.

Ligation in the Triangle of Necessity.—In this operation the patient is placed supine, with the shoulders raised, a sand-pillow under the neck, and the head turned to the opposite side, with the chin raised. The operator stands upon the side operated upon. The incision, three inches long, at a slight angle to the arterial line, runs from the level of the cricoid cartilage downward and inward toward the sternoclavicular joint, following the inner border of the sternocleidomastoid muscle. The surgeon opens the deep fascia, draws the sternocleidomastoid outward, retracts the sternohyoid and sternothyroid muscles inward, and feels for the carotid tubercle of Chassaignac. This tubercle is the costal process of the sixth cervical vertebra, and lies directly under the artery. The tubercle is found about the point at which the omohyoid crosses the carotid. When the tubercle is found we know the situation of the artery, and that the triangle of necessity is below, and the triangle of election above, the tubercle. The operator draws the omohyoid muscle upward, opens the sheath of the artery on its inner side, clears the vessel, and passes the needle from without inward to avoid the internal jugular vein, remembering that the pneumogastric nerve is in the same sheath as the artery and vein, posterior and external to the artery. In this operation the inferior thyroid veins are much in the way, the anterior jugular vein crosses low down, and on the left side, at the root of the neck, the internal jugular vein may be in front of the carotid artery. If the incision is not sufficiently wide, partially divide the sternocleidomastoid or the sternohyoid and thyroid muscles. In the triangle of necessity the descendens noni nerve does not serve as a guide to the sheath of the vessels. (See Pl. 4, Fig. 4.)

Ligation in the Triangle of Election.—The *position* of the patient for this operation is the same as in the preceding one. An incision, three inches in length, is made along the anterior edge of the sternocleidomastoid muscle in the line of the artery, the middle of this incision being opposite the cricoid cartilage. In cutting the superficial fascia, the surgeon avoids the external jugular vein, the course of which should be outlined before making the incision. The line of the external jugular is from the angle of the jaw to the middle of the clavicle. The operator opens the deep fascia, retracts the sternocleidomastoid muscle outward, feels for the carotid tubercle, draws the omohyoid muscle downward, finds the descendens noni nerve upon the sheath, opens the sheath at its inner side, and passes the needle from without inward. This incision permits ligation of either the superior thyroid or the external, internal, or common carotid, and if it be extended up a little there can be tied through it the lingual, and even the facial and occipital, arteries. (See Pl. 4, Fig. 4.)

External Carotid Artery.—The *line* of the external carotid artery is the upper portion of the common carotid line.

Anatomy (Pl. 4, Fig. 3).—The external carotid artery, which is one of the terminal branches of the common carotid, arises on a level with the upper border of the thyroid cartilage and runs to the level of the neck of the condyle of the lower jaw. At its point of origin it is covered only by skin, platysma, and fascia, and the edge of the sternomastoid, but as it ascends it passes beneath the digastric and stylohyoid muscles and into the parotid gland. The glossopharyngeal nerve, styloid process, and stylopharyngeus muscle lie between the external and internal carotid arteries. The hypoglossal nerve crosses the vessel just below the digastric muscle, and the facial and lingual veins cross it a little below the nerve. The first branch is the superior thyroid, which arises from the very beginning of the trunk. The lingual arises on a level with the greater cornu of the hyoid bone. The facial and occipital take origin above the lingual. Each of them can be ligated through the incision of this operation.

Operation.—Place the patient in the same *position* as for ligation of the common carotid. The point of election is between the superior thyroid and the lingual arteries. Make an incision three inches in length at a slight angle to the arterial line, from near the angle of the jaw to opposite the middle of the thyroid cartilage. Cut through the skin, superficial fascia, platysma, and deep fascia, and retract

the sternocleidomastoid muscle outward. Watch for the digastric muscle, find the hypoglossal nerve, and feel for the greater cornu of the hyoid bone. Open the sheath a little below the hyoid cornu and pass the needle from without inward. Ligation of the external carotid has been neglected because ligation of the common carotid is easier.

Internal Carotid Artery.—The *line* of the internal carotid is parallel with and half an inch external to the line of the external carotid.

Anatomy (Pl. 4, Fig. 3).—The internal carotid artery, the other terminal branch of the common carotid, arises on a level with the upper border of the thyroid cartilage and enters the carotid canal. The first inch of the artery is the only point where a ligature is ever applied, this point being covered only by skin, platysma, fascia, and the sternocleidomastoid muscle; higher up it is more deeply placed. It rests upon the vertebræ and the rectus capitis anticus major muscle. The internal jugular vein is in the same sheath and external to the artery; the pneumogastric is in the same sheath, between the artery and the vein, but posterior to both. The superior cervical ganglion of the sympathetic lies behind the origin of the internal carotid, and between the ganglion and the artery is the superior laryngeal nerve.

Operation.—In this operation the *position* of the patient is the same as for ligation of the external carotid. The incision is of the same length and direction as that for ligation of the external carotid, and is half an inch external. The sternocleidomastoid muscle is drawn outward, the external carotid artery is found and drawn inward, the internal carotid is found and cleared, and the needle is passed from without inward. The internal carotid is known by its more external position and by the fact that it gives off no branches.

Superior Thyroid Artery (Pl. 4, Fig. 3).—This branches off from the external carotid below the level of the greater cornu of the hyoid bone, in the triangle of election. It is at first superficial, runs first upward and inward, next downward and forward, passes underneath the omohyoid, sternohyoid, and sternothyroid muscles, and reaches the thyroid gland.

Ligation.—The position of the patient and of the surgeon is the same as for carotid ligation. The artery may be reached through the incision employed for ligation of the external carotid. Gross employed an incision beginning at the edge of the hyoid bone, and running downward and outward to the sternomastoid muscle. The skin and superficial and deep

fasciæ are divided, and the artery is found deeply placed in the triangle of election between the carotid sheath and the thyroid gland.

Lingual Artery.—**Anatomy** (Pl. 4, Fig. 3).—The lingual artery arises from the external carotid opposite the greater cornu of the hyoid bone, passes beneath the digastric and stylohyoid muscles, reaches the margin of the hyoglossus muscle, passes under that muscle, and emerges from beneath it to run along the under surface of the tongue. The place of election for ligation is where the artery is beneath the hyoglossus muscle. Its guide is the hypoglossal nerve, which lies upon the muscle, but at a slightly higher level than the artery.

Operation.—In this operation the patient is placed recumbent with the shoulders raised and the face turned away from the side to be operated upon. The surgeon stands upon the affected side. A curved incision is made from a little external to the symphysis of the lower jaw, downward and outward, to just above the greater cornu of the hyoid bone, and upward and outward to just in front of the facial artery at the lower edge of the lower jaw. The skin, the superficial fascia and platysma, and the deep fascia are incised. The submaxillary gland is cleared and retracted well upward. The fascia below the gland is divided by a transverse incision. The posterior edge of the mylohyoid muscle and the bellies of the digastric muscle are sought for and identified. One of the digastric tendons is retracted down and out (Treves). The hyoglossus muscle is cleared with a dissector; the hypoglossal nerve and ranine vein are found and drawn a little upward. The hyoglossus muscle is divided transversely a little above the hyoid bone and below the level of the hypoglossal nerve. The artery is found under the muscle and the needle is passed from above downward.

Facial Artery.—**Anatomy** (Pl. 4, Fig. 3).—Arises from the external carotid a little above the lingual, runs upward and forward beneath the body of the inferior maxillary bone, passes along a groove in the posterior and upper surface of the submaxillary gland, crosses the body of the lower jaw at the lower anterior edge of the masseter muscle, and passes forward and upward to the angle of the mouth and side of the nose.

Ligation (Pl. 4, Fig. 4).—The facial artery is rarely ligated in the cervical portion, but may be reached through the incision employed for ligation of the external carotid. The

vessel may be tied before it crosses the submaxillary gland, the stylohyoid and digastric muscles being drawn aside. The vessel is reached in the facial portion of its course by a one-inch cut at the anterior edge of the masseter muscle. Branches of the facial nerve are pushed aside. The needle is passed from behind forward to avoid the vein (Jacobson).

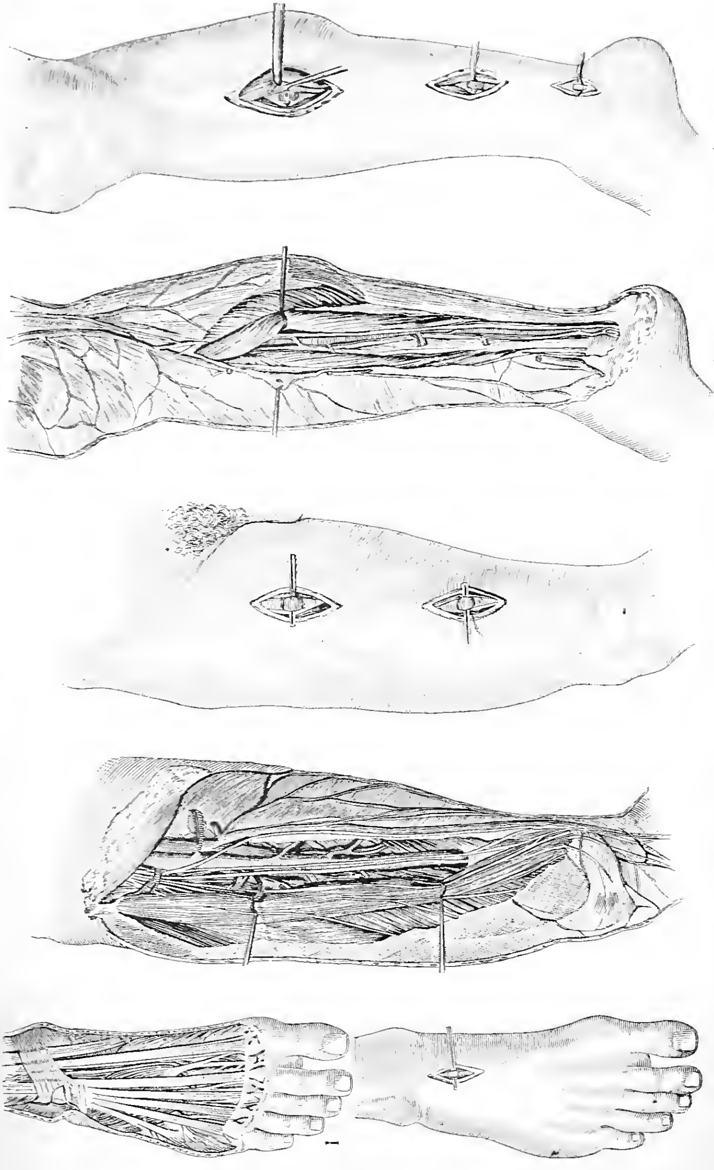
Temporal Artery.—The line of the temporal artery passes " upward over the root of the zygoma, midway between the condyle of the jaw and the tragus " (Jacobson).

Anatomy.—The temporal artery arises from the external carotid behind the condyle of the jaw and in the parotid gland, passes over the zygoma, and divides into two terminal branches.

Ligation.—The patient is placed recumbent and the head is turned to the opposite side. An incision an inch in length is made, the superficial structures and dense fascia are divided, the vein is retracted backward, and the needle is passed from behind forward.

Occipital Artery.—Takes origin from the posterior surface of the external carotid, below the digastric muscle and opposite the point of origin of the facial artery. It ascends beneath the digastric and stylohyoid muscles and parotid gland; the hypoglossal nerve hooks around it from behind forward. It crosses the internal carotid artery, the internal jugular vein, the pneumogastric and spinal accessory nerves; passes between the mastoid process of the temporal bone and the atlas; grooves the temporal bones; penetrates the trapezius muscle, and ascends over the occiput.

Ligation.—This vessel can be ligated near its origin through the same incision as is employed to reach the external carotid. The hypoglossal nerve is avoided. To tie back of the mastoid process, place the patient in the same position as for ligation of the carotid. Carry an incision from the tip of the mastoid upward and backward, reaching a point midway between the mastoid and the occipital protuberance (Jacobson). Cut the skin, the fascia, the sternocleidomastoid, the splenius capitis, and possibly a portion of the trachelomastoid muscles. Bring the head toward the operator in order to relax the structures, retract the edges of the wound, and clear the artery where it lies between the mastoid process and the transverse process of the atlas (Jacobson). An electric forehead-light is of great assistance in finding the vessel. Pass the needle away from the vein or veins (there are often several).



1, Anatomy, 2, Ligation, of the Dorsalis Pedis Artery. 3, Anatomy, 4, Ligation, of the Femoral Artery. 5, Anatomy, 6, Ligation, of the Posterior Tibial Artery. (From Bernard.)

Dorsalis Pedis Artery.—The *line* of the dorsalis pedis artery is from the middle of the front of the ankle-joint to the middle of the base of the first interosseous space.

Anatomy (Pl. 5, Fig. 1).—The dorsalis pedis is a continuation of the anterior tibial artery, and it runs from the bend of the ankle to the proximal extremity of the first interosseous space, where it divides into the dorsalis hallucis and the communicating arteries. The artery rests, from above downward, upon the astragalus, scaphoid, and internal cuneiform bones, and at its point of bifurcation lies between the heads of the first dorsal interosseous muscle. It may lie in some persons a little external to this course. It is held upon the bones by a distinct layer derived from the deep fascia. This artery is covered by skin, by superficial and deep fascia, and by the annular ligament above, and is sometimes partly overlaid by the extensor proprius pollicis muscle, and is crossed, just before its bifurcation, by the innermost tendon of the extensor brevis muscle. The inner tendon of the extensor communis digitorum is to the outer side of the vessel; the tendon of the extensor proprius pollicis is to the inner side, and is a guide. The artery is ligated in the dorsal triangle of the foot—a space which is bounded above by the lower edge of the annular ligament, externally by the inner tendon of the extensor brevis, and internally by the tendon of the extensor proprius pollicis. The artery has venæ comites; the anterior tibial nerve lies, as a rule, to its inner side, but may be found upon the artery or to its outer side, and the inner division of the musculocutaneous nerve is external to the vessel in the superficial parts.

Operation (Pl. 5, Fig. 2).—In this operation the patient is placed supine with the leg and foot extended. Heath flexes the leg partly and rests the sole of the foot directly upon the table. The surgeon stands below the extremity, and cuts from above downward. Make an incision two inches in length along the arterial line, beginning opposite the lower edge of the annular ligament and running along by the tendon of the extensor proprius pollicis; cut through the skin and superficial and deep fascia; have the toes extended; retract the tendon of the extensor proprius pollicis inward, and the tendon of the extensor communis digitorum outward; clear the artery, find the nerve, try to separate the venæ comites, and pass the needle from the nerve.

Anterior Tibial Artery.—To locate the *line* of the anterior tibial, mark a point midway between the head of the fibula and the tuberosity of the tibia, drop one inch, and

draw a line from the second point to the middle of the front of the ankle-joint.

Anatomy.—The anterior tibial artery is one of the terminal branches of the popliteal. It arises opposite the lower border of the popliteus muscle, passes forward between the two heads of the posterior tibial muscle, comes to the front of the leg through an opening in the interosseous membrane, and runs down to the middle of the front of the ankle-joint. In the upper two-thirds of its course it rests upon the interosseous membrane, to which it is fastened by firm fascia; in the lower third it lies first upon the front of the tibia and then upon the anterior ligament of the ankle-joint. For its upper two-thirds the artery has the tibialis anticus muscle just internal to it; at the junction of the middle and lower thirds the extensor proprius pollicis comes from the outside and lies either upon the artery or to its inner side for the rest of its course. Externally in its upper third is the extensor communis digitorum, in the middle third is the extensor proprius pollicis; in the lower third, the proprius pollicis having crossed to the inner side, the extensor communis digitorum again becomes the outer boundary. The artery is covered by skin and by superficial and deep fascia. In its upper third it is deeply placed between the muscles; in its middle third it is less overlaid by muscle; in its lower third it is superficial except where it is crossed by the extensor proprius and where it is covered by the annular ligament. The artery has venæ comites. In the lower three-fourths of its course it is accompanied by the anterior tibial nerve, which in its course in the upper third of the leg is external to the artery; in the middle third it is external and a little in front of the artery; and in the lower third it is external to or upon the artery (Pl. 4, Fig. 5).

Operations.—The ligations of the anterior tibial (Pl. 4, Fig. 6) are (1) of the lower third; (2) of the middle third; and (3) of the upper third. In all these ligations the patient is placed recumbent with the leg extended, and the surgeon stands to the outer side of the extremity, cutting from above downward on the right side and from below upward on the left side.

Ligation of the Lower Third.—Make an incision three inches long in the line of the artery and over the annular ligament. This incision is external to the tibialis anticus muscle and half an inch from the outer border of the tibia (Barker). Divide the skin and fascia, retract the tendon of the tibialis anticus inward, and the tendon of the extensor

proprius pollicis outward, along with the tendons of the extensor communis. Flex the ankle-joint to relax the tendons, and clear the artery. Draw the nerve external and pass the ligature from without inward. In order to recognize the muscles in this as in other ligations, rely largely upon the finger while the muscles are being moved.

Ligation of the Middle Third.—In this operation the procedure is similar to the above. Remember that the nerve lies in front of the vessel and that the extensor proprius pollicis muscle is external. The nerve is retracted outward and the needle is passed from the nerve. A good rule for detecting the artery is to find the outer edge of the tibia and by this locate the interosseous membrane, and then, by passing out along this membrane, discover the artery.

Ligation of the Upper Third.—Make an incision three inches long in the arterial line. On opening the deep fascia, do not rely on the eye for finding the muscular interspace, as often the latter cannot be seen, and neither a white nor a yellow line is reliable. Place the index-finger deep in the wound and have the tibialis anticus and extensor communis digitorum muscles successively rendered tense by an assistant. In opening the interspace use the handle of the knife. Relax the muscles, retract the tibialis anticus inward, and draw the extensor communis digitorum outward. Find the interosseous membrane where it is attached to the edge of the tibia, and the artery will be found upon this membrane, between the tibia and the nerve. Clear the vessel and pass the ligature from without inward to avoid the nerve.

Posterior Tibial Artery.—The *line* of the posterior tibial is from the middle of the popliteal space to a point midway between the tip of the inner malleolus and the point of the heel (Pl. 5, Figs. 5, 6).

Anatomy.—The posterior tibial is the larger of the two terminal branches of the popliteal. It arises opposite the lower border of the popliteus muscle, passes down between the deep and superficial flexor muscles to midway between the tip of the malleolus and the point of the heel, and divides into the external and internal plantar vessels. In the upper third of its course it is very deeply placed midway between the tibia and fibula; in its middle third it is less deep, having passed inward; and in its lower third it is superficial. At the ankle the artery is beneath the annular ligament. From above downward the posterior tibial artery rests upon the posterior tibial muscle, the flexor longus digitorum muscle, the posterior surface of the tibia, and the internal lateral

ligament of the ankle-joint. For the first inch or two of the course of the artery the posterior tibial nerve is to the inner side; the nerve then crosses to the outer side, and remains in that relative position throughout the rest of the course of the artery. When the knee is partly flexed and the leg is laid upon its outer surface the artery is between the operator and the nerve, and the nerve is between the artery and the table. Back of the malleolus, in the first compartment, lies the posterior tibial muscle; in the next compartment is the flexor longus digitorum muscle; in the next are the artery and nerve; and in the most posterior is the flexor longus pollicis muscle.

Operations.—*Ligation Back of the Malleolus.*—In this operation the patient is placed recumbent with the thigh abducted and the leg flexed and resting upon its outer surface. The surgeon stands to the outer side. Make a two-inch semilunar incision corresponding in its curve to the malleolus and half an inch posterior to its margin. Cut down to the annular ligament, incise the ligament, and find the artery and venæ comites. Clear the vessel and pass the needle from behind forward (to avoid the nerve, which is here posterior and external). Do not make the preliminary incision nearer the malleolus than half an inch, as the sheath of the tibialis posticus muscle will then surely be opened. In closing the wound, suture the ligament by buried sutures of catgut before closing the superficial parts (Pl. 5, Fig. 6).

Ligation in the Middle of the Leg.—In this operation the patient is placed in the same position as for the ligation back of the malleolus. Feel for the inner border of the tibia, and make an incision four inches long one inch behind the osseous border, parallel with it, and extending through skin and superficial and deep fascia. Draw the gastrocnemius muscle outward. Incise the soleus muscle, but not the fascia beneath the soleus; cut this fascia, after dropping the handle of the knife so that the blade is at right angles with the plane of the tibia. Clear the artery; pass the needle from without inward (Pl. 5, Fig. 6).

The **popliteal artery** is almost never ligated in continuity. It can be tied at the upper portion of the popliteal space, at the lower portion of the popliteal space, or at the inner side of the thigh.

Anatomy (Fig. 105).—The popliteal artery is the continuation of the femoral, and runs from the opening in the adductor magnus muscle to the lower margin of the pop-

liteus muscle. This vessel runs downward and outward behind the knee-joint and in the popliteal space. The ham, or popliteal space, is a lozenge-shaped space, which above the joint is bounded on the outer side by the biceps muscle, and on the inner side by the semitendinosus, semimembranosus, gracilis, and sartorius muscles, while below the joint it is bounded externally by the plantaris and outer head of the gastrocnemius muscles, and internally by the inner head of the gastrocnemius muscle. The floor of this space is formed by the surface of the femur, the posterior ligament of the knee-joint, the end of the tibia, and the popliteus

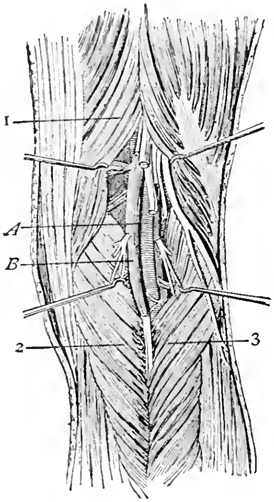


Fig. 105.—Anatomy of popliteal artery (Bernard and Huette).

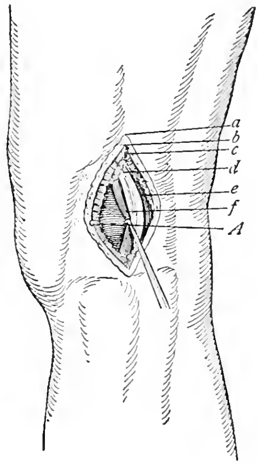


Fig. 106.—Ligation of popliteal artery in its upper third (Bernard and Huette.)

fascia. The internal popliteal nerve passes down the middle of the popliteal space; it is superficial to the vessels in the upper half of the space, and external to them; it is internal to the vessels in the lower half of the space. The external popliteal nerve is in the outer side of the space. The popliteal vein is between the nerve and the artery. Above the knee-joint it is to the outer side of the artery, but below the knee-joint it is to the inner side. The artery lies deeply in the space.

Ligation in Upper Third.—Place the patient prone. The surgeon stands to the outer side of the limb and makes a vertical incision three inches in length along the outer margin

of the semimembranosus muscle, exposes the popliteal nerve, retracts the muscle inward and the nerve outward, exposes the artery, separates it from the other structures, and passes the needle from without inward (Fig. 106).

Ligation in Lower Third.—Make a three-inch vertical incision between the heads of the gastrocnemius muscle. Avoid the external saphenous vein and nerve, and retract them with the popliteal nerve. Separate the artery from the vein and pass the needle from within outward.

Femoral Artery.—The *line* of the femoral artery is from midway between the anterior superior spine of the ilium and the symphysis pubis to the adductor tubercle on the inner condyle of the femur, the thigh being abducted and resting upon its outer surface (Pl. 5, Fig. 3).

Anatomy.—The femoral artery is the continuation of the external iliac trunk; it extends from the lower border of Poupart's ligament to the opening in the adductor magnus muscle, and hence occupies the upper two-thirds of the thigh. The artery for its first five inches is superficial, lying in Scarpa's triangle, a space which is bounded externally by the sartorius muscle and internally by the adductor longus, its base being Poupart's ligament and its floor being composed of the psoas, iliacus, pectineus, and adductor longus muscles, and often the adductor brevis. The artery enters the triangle as the common femoral, but after a two-inch course it divides into the profunda (which passes deeply) and the superficial femoral. The latter vessel is the one alluded to in this section.

At the base of Scarpa's triangle the vein is internal, the artery is between, and the nerve is external (V. A. N.) At the apex of the triangle the vein is internal and a little posterior. At the apex of the triangle the superficial femoral passes under the sartorious muscle and enters into Hunter's canal, which occupies the middle third of the thigh and which terminates at an opening in the adductor magnus muscle. Hunter's canal is bounded externally by the vastus internus muscle, internally by the adductors longus and magnus, and its roof is fascia which stretches from the adductor longus to the vastus internus. In Hunter's canal the vein is behind the artery in the upper part, but external to it in the lower part, and is firmly attached to the artery. There may be two veins. Inside Hunter's canal, but outside the femoral sheath, is the long saphenous nerve, which crosses the artery from without inward.

A way to remember the relation of the femoral vein to

the femoral artery is to recall the fact that the relation of the vein to the artery is always contrary to the relation of the sartorius muscle to the artery: when the sartorius muscle is external to the artery the vein is internal, as at the base of Scarpa's triangle; when the sartorius muscle is crossing in front toward the inside of the artery, the vein is passing at the back to the outside, as at the apex of Scarpa's triangle; when the muscle is over the artery the vein is back of it, as in the upper third of Hunter's canal; and when the muscle is to the inside of the artery the vein is to the outside, as in the lower two-thirds of Hunter's canal. In a ligation at the apex of Scarpa's triangle the inner edge of the sartorius is the guide. In a ligation in Hunter's canal the long saphenous nerve is the guide.

Operations.—*Ligation of the Superficial Femoral at the Apex of Scarpa's Triangle.*—In this operation the *position* of the patient is supine with the thigh and leg partly flexed, and the thigh abducted, everted, and rested upon its outer surface on a pillow. The operator stands to the outer side of the extremity. From a point corresponding to the middle of Scarpa's triangle, and two and a half inches below Poupart's ligament, make a three-inch incision in the arterial line. Cut the skin and superficial fascia. The saphenous vein will not be seen unless the incision is internal to the arterial line; if this vein is seen, draw it inward. Open the fascia lata, find the inner border of the sartorius muscle, and draw it outward. The fibers of this muscle run downward and inward, thus distinguishing it from the adductor longus, whose fibers run downward and outward. Open the common sheath for the artery and vein, and then incise the individual arterial sheath. Clear the artery and pass the ligature from within outward (Pl. 5, Fig. 4).

Ligation of the Superficial Femoral in Hunter's Canal.—In this operation the *position* of the patient is the same as in the ligation at the apex of Scarpa's triangle. Make a three-inch incision in the middle third of, but above the middle of, the thigh, parallel with the arterial line and half an inch internal to it (Barker). Incise the skin and superficial fascia, look out for the internal saphenous vein, open the fascia lata, find the sartorius muscle, and retract it inward, thus exposing the roof of Hunter's canal, which is to be opened for an inch or more. Within the canal is seen the long saphenous nerve, usually upon the sheath. Open the sheath of the artery, clear the vessel, and pass the needle from without inward.

Iliac Arteries.—The *line* of the common and external iliac artery is from a point half an inch below and half an inch to the left of the umbilicus to midway between the anterior superior spine of the ilium and the pubic symphysis. The upper third of this line represents the common iliac, and the lower two-thirds the external iliac (Pl. 2, Fig. 4).

Anatomy.—The common iliac arteries arise from the aorta opposite the left side and lower border of the fourth lumbar vertebra, and extend to the upper margin of the right and left sacroiliac joints, where they each bifurcate into an external and an internal iliac. The common iliac arteries lie upon the fifth lumbar vertebra, are covered with peritoneum, and are crossed by the ureters. In women the ovarian arteries cross the common iliacs. Each common iliac vein lies to the right side of its associated artery. The right common iliac artery has in front of it, besides the peritoneum and ureter (in women also the ovarian artery), the ileum, branches of the superior mesenteric artery, and branches of the sympathetic nerve. The left common iliac artery has in front of it, in addition to structures common to both sides (ureter, ovarian artery, sympathetic branches), branches of the inferior mesenteric artery and the sigmoid flexure with its mesocolon. The internal iliac artery runs from the sacroiliac joint to the upper margin of the great sacrosciatic foramen. It is very rarely ligated (only for gluteal aneurysm, for uncontrollable hemorrhage from the gluteal or sciatic arteries, or to produce atrophy of the prostate gland). The external iliac artery runs from the sacroiliac joint along the pelvic brim, upon the inner edge of the psoas muscle, to Poupart's ligament. The external iliac vein is internal to the artery. On the right side, high up, it passes behind the artery. The external iliac artery has in front of it peritoneum and subserous tissue (Abernethy's fascia). The ileum crosses the right, and the sigmoid flexure crosses the left, external iliac artery. The genital branch of the genitocrural nerve crosses the artery low down, and the circumflex iliac vein crosses it just before it terminates in the femoral. The spermatic vessels and the vas deferens in the male, and the ovarian vessels in the female, lie upon the artery near its termination. Sometimes the ureter crosses the vessel near its point of origin. The spermatic vessels in the male and the ovarian vessels for a part of their course in the female rest upon the inner side of the artery.

Ligation of the Iliac Arteries after Abdominal Section.—The best method for ligating the common, the external, or the

internal iliac is by abdominal section. The patient is placed in the Trendelenburg position. The abdomen is opened in the midline below the umbilicus. The intestines are lifted toward the diaphragm, and are held up by gauze pads. The edges of the incision are retracted. The vessel to be tied is located and the point for ligation is selected. The posterior layer of the peritoneum is opened over the selected point, the vessel is cleared, and the threaded Dupuytren's aneurysm-needle is passed in a direction away from the vein. In ligating either common iliac, pass the needle from right to left. In ligating the external iliac, pass the ligature from within outward. In ligating the internal iliac, pass the needle from within outward. It is not necessary to suture the posterior layer of peritoneum. The abdomen is closed without a drain. In these operations be sure to push the ureter out of the way. This method of operating is endorsed by Dennis, Hearn, Marmaduke Shield, Mitchell Banks, and others who have employed it.

Ligation of the External Iliac by Abernethy's Extraperitoneal Method (Pl. 2, Fig. 4).—The patient is placed recumbent with the thighs extended during the first incisions; but in the later stages of the operation the thighs are flexed a little, to relax the abdominal structures. The operator stands to the outer side. The surgeon will find the artery by the side of the psoas muscle. Mark a point one inch above and one inch external to the middle of Poupart's ligament, and another point one inch above and one inch internal to the anterior superior iliac spine (Barker). Join these two points by a curved incision four inches long and convex downward. Cut the skin, the fat, the two oblique, and the transversalis muscles; open the transversalis fascia, separate the peritoneum toward the vessels, and draw it inward by a broad retractor, and look for the artery along the pelvic brim. The anterior crural nerve is seen to the outer side of the artery, the external iliac vein is to the inner side of the artery, and the genitocrural nerve is upon the artery. Clear the artery near its middle and pass the ligature from within outward. In Sir Astley Cooper's method of ligation the inguinal canal is opened; in Abernethy's method the inguinal canal is not opened.

The Gluteal Artery.—This vessel is a continuation of the posterior division of the internal iliac. It emerges from the great sacrosciatic foramen at the upper border of the pyriformis muscle. It rests upon the glutæus minimus muscle, divides into three branches, and is covered by the

25

glutæus maximus muscle. The superior gluteal nerve lies inferior to the artery (Fig. 107).

Ligation.—The patient should be prone. The surgeon stands to the outer side. The incision corresponds to a line

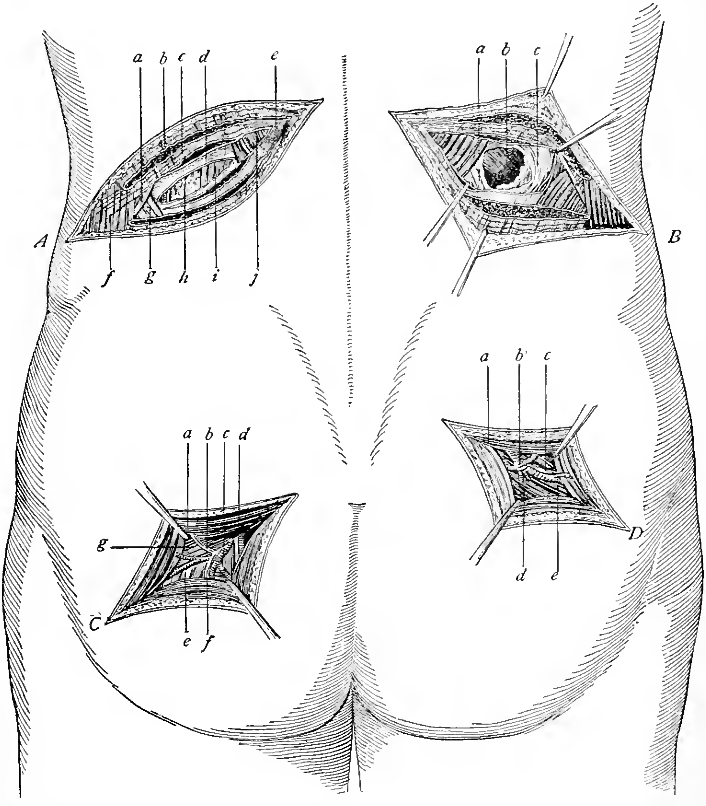


Fig. 107.—*A*, Nephrotomy: *a*, last dorsal n.; *b*, latissimus dorsi m.; *c*, serratus post. inferior m.; *d*, middle layer of lumbar fascia; *e*, outer layer; *f*, ext. oblique m.; *g*, int. oblique m.; *h*, perinephritic (extraperitoneal) fat; *i*, quadratus lumborum m.; *j*, erector spinæ m. *B*, Nephrotomy: *a*, first lumbar n.; *b*, kidney; *c*, transversalis fascia. *C*, Ligature of the sciatic and internal pudic arteries, and exposure of the great sciatic, small sciatic, and internal pudic nerves: *a*, glutæus maximus m.; *b*, inf. gluteal n.; *c*, sciatic a; *d*, int. pudic a. and n.; *e*, great sciatic n.; *f*, small sciatic n.; *g*, pyriformis m. *D*, Ligature of the gluteal artery and exposure of the superior gluteal nerve: *a*, glutæus maximus m.; *b*, gluteal a.; *c*, superior gluteal n.; *d*, pyriformis m.; *e*, glutæus medius m. (Kocher.)

drawn from the posterior superior iliac spine to the upper border of the great trochanter. Divide the skin, fascia, glutæus maximus muscle, and the fascia over the glutæus medius muscle, and retract the glutæus medius upward. Feel for the great sacrosciatic foramen, and at this point the artery

is found above the pyriformis muscle. Clear the vessel and pass the needle from below upward (see Kocher's *Operative Surgery*).

The Sciatic Artery.—This artery is the larger of the terminal branches of the anterior division of the internal iliac artery. It passes to the lower portion of the great sacrosciatic foramen, lying back of the internal pudic artery, and resting upon the sacral plexus of nerves and pyriformis muscle (Gray). It leaves the pelvis between the pyriformis and coccygeus muscles, and passes downward between the ischial tuberosity and great trochanter. It is covered by the glutæus maximus muscle, rests upon the gemelli, internal obturator and quadratus femoris muscles, has the great sciatic nerve external to it, and the small sciatic nerve external and posterior (Fig. 107).

Ligation.—The patient lies prone. The surgeon stands to the outer side. The incision "corresponds to the middle two-thirds of a line extending from the posterior inferior iliac spine to the base of the great trochanter."[1] Divide the skin, fat, fascia, and the glutæus maximus muscle. Find the artery at the lower border of the pyriformis muscle and trace it to its point of emergence from the pelvis. Pass the ligature from without inward.

Internal Pudic Artery.—This artery is one of the terminal branches of the anterior trunk of the internal iliac. It passes to the lower margin of the great sacrosciatic foramen, and leaves the pelvis between the pyriformis and coccygeus muscles, crosses the ischial spine, and again enters the pelvis by the lesser sacrosciatic foramen. The vessel is accompanied by the internal pudic nerve (Fig. 107).

Ligation.—The position of the patient and the incision are the same as for ligation of the sciatic artery. The artery is found below the ischial spine. Pass the needle from below upward to avoid the nerve.

Ligation of the Abdominal Aorta.—This operation was first performed by Sir Astley Cooper in 1817. The patient lived but a few hours. Eleven cases of ligation of the aorta have been published, and there were eleven deaths. The patient of Monteiro of Rio Janeiro lived for ten days. The circulation was entirely restored in the limbs, and the man died from hemorrhage resulting from the ulceration produced by a septic ligature. This case proves that under certain circumstances the operation is feasible, and in desperate cases it must be considered as a possible means of treatment.

[1] Kocher's *Operative Surgery*, by Stiles.

I lately assisted Prof. Keen in a remarkable case, in which the aorta was ligated above the renals for aneurysm. The man lived seven weeks. The circulation in the legs was restored in twenty-four hours. Urinary secretion continued. Death was due to the ligature cutting completely through the aorta.

Murray's operation aims to avoid opening the peritoneum. An incision is made from just below the tip of the tenth rib to a point one inch internal to the anterior superior iliac spine. The peritoneum is separated from the abdominal wall until the vessel is reached. Cooper's operation by abdominal section is the preferable procedure.

Operation by Abdominal Section (*Cooper's Operation*).—*Instruments Required*.—Those used in any ligation, with the addition of an aneurysm-needle with a large curve and a very long handle. With an ordinary instrument it is extremely difficult to pass the ligature. It would be a great advantage to use an instrument which, after being passed under the vessel, could have a central eyed shaft projected, as is the center shaft of a Bellocq cannula. Floss silk is probably the best ligature-material.

If the patient is much exhausted, an assistant should infuse salt solution in a vein during the operation. In Keen's case there was profound shock, but the moment the ligature was tightened it passed away.

Operation.—The patient should be placed upon his back. The surgeon stands to the right of the patient and opens the abdomen in the median line, a little above the level of the aneurysm. The intestines are packed aside, the posterior layer of the peritoneum is divided, the surface of the aorta over a small area is cleared of nerves, the plexuses being separated with a blunt dissector.

The needle is passed from right to left. A double ligature of floss silk should be passed and the ends should be tied with a stay-knot. The wound is closed and dressed.

It has been suggested, I think by Wyeth, that it might be wise to only partially tighten the ligature at first, completing the occlusion of the artery after a day or two. Such a procedure would certainly give a better chance for the collaterals to dilate, and restore circulation in the legs.

Unfortunately, in an aneurysm, the vessel will usually be extensively diseased, and ligation will be out of the question. If, however, a normal region is found, the chance of success in a case of aneurysm will be greater than in a case of hemorrhage from a branch of the aorta, because, in a case of aneu-

rysm, the probabilities are that the collaterals are somewhat distended before a ligature is applied.

XIX. DISEASES AND INJURIES OF BONES AND JOINTS.

1. Diseases of the Bones.

Atrophy of bone is a diminution in the amount of bony matter without change in osseous structure. It arises from want of use (as seen in the wasting of the bone of a stump) or from pressure (as seen in the destruction of the sternum by an aneurysm of the aorta). *Eccentric* atrophy is the thinning of a long bone from within, the outer surface being unchanged. It is usually a senile change. *Concentric* atrophy means a thinning of the outer surface of the shaft, causing a lessened diameter. It is usually linked with eccentric atrophy.

Hypertrophy of bone may be due to increased blood-supply (as is seen in chronic epiphyseal inflammation), the bone growing much more than does its fellow. It may arise from excessive use or from strain, as is seen in the increased size of the fibula when the tibia is congenitally absent (Bowlby).

Tumors of Bone.—Bones give origin to both innocent and malignant tumors. Myeloid sarcoma takes origin in the endosteum and expands the bone. The fasciculated sarcoma is a periosteal growth. Besides these growths there are osteomata, chondromata, and secondary deposits of cancer and sarcoma. There is no such thing as primary cancer of bone. A bone may become cystic, and occasionally the cysts are due to hydatids. Gummata are frequently met with.

Actinomycosis of bone is most usual in the jaw, but may attack the orbit, ribs, sternum, or limbs (see p. 235).

Tuberculosis of bone tends especially to appear in the cancellous ends of long bones. Is apt to caseate and destroy large amounts of bone. The bone does not sclerose, but undergoes alterations of an osteoporotic nature (see p. 196).

Osteitis, Periostitis, and Osteoperiostitis.—Osteitis, or **inflammation of bone**, may be due to traumatism, to a constitutional malady or diathesis, to the extension of inflammation from some other structure, or to infection. In inflammation of bone the exudate and leukocytes pass into the Haversian canals and spaces and the canaliculi, and the cells of the exudate and the bone-corpuscles proliferate, the

bone undergoing thinning (rarefaction), not because of pressure, but because of absorption by voracious leukocytes and osteoclasts. This process of rarefaction enlarges all the bony spaces, and by destroying septa throws many of the spaces into one. If the surface of a bone inflames, the periosteum will be separated more or less by the exudation, and the bone will be covered with little pits or erosions made by the leukocytes. Inflamed bone is so soft that it can readily be cut with a knife.

Osteitis may terminate in *resolution* or it may terminate in *sclerosis*, the exudate being converted first into fibrous tissue and next into dense bone with only a few small cancellous spaces. If the exudation is under the periosteum, the bone will be thickened at this point, bone stalactites marking the points of passage of the vessels. Osteitis may terminate in *suppuration*, this condition being often called "*caries*." In tubercular osteitis caseation of the inflammatory products is very apt to arise (tubercular or strumous caries). Acute osteitis may terminate in *necrosis*, the inflammatory exudate compressing the vessels in their bony canals, a portion of the bone being in consequence deprived of nutritive material. The portion cut off from nutritive fluid dies *en masse* (necrosis). Osteitis is usually associated with more or less periostitis. A simple acute periostitis without involvement of the bone may arise from traumatism or strain; but in all severe cases of periostitis, in all chronic cases, in all cases due to syphilis, rheumatism, measles, scarlatina, or enteric fever the bone is involved at the same time or subsequently. In syphilitic states gummatous degeneration frequently ensues.

Symptoms of Osteitis and Osteoperiostitis.—As a chronic process *osteitis* is most commonly found in the femur. Its history usually exhibits a record of an antecedent injury or chilling of the body. Pain is severe, boring or aching in character, deep-seated, worse at night, and aggravated by a dependent position of the part. The symptoms closely resemble those of periostitis, with which disease it is almost sure to be linked. Tenderness exists on percussion, and sometimes on pressure. Subperiosteal swelling, fusiform in shape, is noted; cutaneous edema and discoloration are observed if a superficial bone is inflamed. In syphilis, atrophic osteitis may attack the cranial bones and produce softening or even perforation, or osteophytic osteitis may arise, exostoses being formed. *Osteoperiostitis* may be acute or chronic, circumscribed, or diffused, and may terminate in resolution, organization, or suppuration. It arises from cold,

blows, wounds, strains, the spread of adjacent inflammation, specific febrile maladies, pyogenic infection, syphilis, rheumatism, or tuberculosis. The symptoms are pain (which is worse at night and which is aggravated by motion, pressure, or a dependent position), swelling, edema, and discoloration of the soft parts. Pain in the syphilitic form is not so severe as in other varieties. *Acute necrosis* or *diffuse periostitis*, a septic inflammation of bone and periosteum, is commonest in boys about the age of puberty. It is usually due to cold, a specific fever, or injury, and most often affects the tibia or femur; the symptoms locally are redness, swelling, and severe pain; constitutionally there are rigors, fever, and sometimes convulsions. Necrosis is apt to result. Pyemia is common. In *simple acute periostitis* a swelling is felt upon the osseous surface. The swelling is firmly fixed and is very tender, but the bone itself is not enlarged. There is some local heat, discoloration, often fever, and the patient complains of an aching pain, which is worse at night.

Periostitis due to strain demands some special attention. Sir James Paget, years ago, pointed out that muscular exertion might cause periostitis. C. T. Dent has written a valuable article upon this subject.[1]

It is common to hear football-players complain of some swelling of the knee-joint. Examination finds tenderness over the tubercle of the tibia with slight swelling of the joint. Dent points out that pain is felt on straightening the leg, not on rotating it. The same observer states that omnibus-drivers suffer from periostitis of the fibula, due to pressing forcibly against the foot-board; those who ride may develop periostitis of the adductor insertion (riders' bone); the victims of flat-foot may labor under periostitis of the inner tuberosity of the os calcis; bar-keepers, from working a beer-pump, may get periostitis of the scapula, pain being marked on contracting the biceps; a housemaid may develop periostitis at the points of bony origin of the great pectoral from the chest, the condition being due to sweeping and scrubbing.[2]

Treatment of Osteitis and Osteoperiostitis.—In syphilitic forms the local treatment consists of rest, elevation of the part, the application of iodin and mercurial ointment, and bandaging. Specific treatment is by the stomach or hypodermatically. Operation is rarely justifiable. In other forms, if the case be recent and severe, put the patient to bed, place the limb in a splint and elevate it, apply leeches, employ cold,

[1] *Practitioner*, October, 1897. [2] *Ibid.*

apply a bandage, and give salines and iodid of potassium internally. Later use ichthyol inunctions locally and apply a hot water-bag. Morphin is administered for pain. If these means fail, order counterirritation by iodin and blue ointment or blisters, and apply heat locally. In severe cases take a tenotome and slit the periosteum subcutaneously to relieve tension; this procedure often quickly relieves the pain. Some cases demand a longitudinal osteotomy, which is performed by taking Hey's saw and dividing the bone longitudinally into the medullary canal. If pus forms, drain at once.

Diffuse osteoperiostitis requires early and free incisions, antiseptic irrigation, drainage, rest and elevation of the limb, and strong supporting and stimulating treatment. Amputation is sometimes demanded, as when the patient grows weaker and weaker even after incision, and when a joint is seriously involved. If the necrosis affects the entire shaft, which separates from its epiphyses, and new bone has not yet formed from the periosteum, make a subperiosteal resection of the shaft.

Chronic periostitis is usually syphilitic. A *node* is a chronic inflammation of the deep periosteal layers. Nodes occurring early in the secondary stage remain soft and soon pass away under treatment, but those occurring two years or more after infection are apt to cause a bony deposit. A node may soften, leaving a sinus, at the bottom of which is a piece of dead bone. Gumma of the periosteum is one form of node which is apt to produce caries or necrosis.

Osteoplastic periostitis accompanies chronic osteitis and causes the deposit of new bone, which undergoes sclerosis. The chief *symptom* is aching pain, which is worse when the patient is warm in bed, and is aggravated by damp and wet. A swelling is found at the seat of pain (often over the tibia, ulna, clavicle, or sternum). The soft parts are uninflamed and move freely unless softening or suppuration has occurred. Tenderness is manifest.

Treatment of Chronic Periostitis and Osteoplastic Periostitis.—For the nodes of early syphilis use mercurial treatment; for the nodes of late syphilis give mercury and large advancing doses of iodid of potassium. Blisters, blue ointment, and iodin are used locally, and subcutaneous division of the periosteum is of value. If suppuration occurs, incise antiseptically.

Abscess of bone is usually due to tubercular infection. It is always chronic, never acute. A very acute inflamma-

tion, such as is induced by pyogenic organisms, causes acute necrosis rather than an acute abscess. After typhoid fever an area of suppuration may slowly form in the head of a long bone, due to the action of typhoid bacilli. After a tubercular abscess forms mixed infection may take place, the seat of abscess being a point of least resistance. Chronic abscess of bone was first described by Sir Benjamin Brodie, and is often called "Brodie's abscess." It occurs in the cancellous structure of the ends of bones—usually in the head of the tibia, sometimes in the femur or humerus. A tubercular abscess of bone may follow a slight injury, inducing osteitis, which constitutes a point of least resistance. Bacteria lodge and multiply; bone rarefaction leads to the formation of a cavity, the inflammatory products caseate and sometimes suppurate, and the surrounding bone thickens and hardens because of growth from the periosteum. The abscess is apt to break into a joint, as the joint-surface is not covered by periosteum and no barrier of bone is there formed. Brodie's abscess may induce necrosis.

Symptoms.—The symptoms are like those of osteoperiostitis, only they are localized and persistent. These symptoms are thickening of the bone and soft parts, edema and discoloration of the skin over the seat of trouble, tenderness, constant pain (subject to violent exacerbations, worse at night when warm in bed, and made worse by motion, pressure, or a dependent position), and attack after attack of synovitis in the nearest joint. Fever and sweats may be noted.

Treatment.—In treating bone-abscess, trephine the bone at the point of greatest tenderness, and if the abscess is missed, follow the advice of Holmes and perforate the wall of bone with the trephine, opening in several directions to discover the pus. It is often easy to open into the abscess with a chisel or gouge. After opening the cavity scrape its walls thoroughly, dry with gauze, touch with pure carbolic acid, and pack with iodoform gauze. If the abscess opens into a joint, trephine the bone and open, irrigate, and drain the joint.

Caries was a term used formerly to signify suppuration or molecular death of bone. In some cases caries means suppurative osteitis, in others, tubercular osteitis, in still others, gummatous osteitis. Typhoid fever is occasionally followed by a carious condition of bone. Osteitis is apt to become purulent when the bone is exposed to the air, when rest is not secured, when the health of the individual is below

normal, when a foreign body such as a bullet is in the bone, or when tubercle or syphilis exists. The term is rarely used to-day except loosely, and then usually to signify tubercular disease of bone. When caries arises, the softened and granulating bone breaks down and is discharged through a sinus. After drainage is secured organization, sclerosis, and healing may result. In these cases new bone may form, and a cure result.

Tubercular caries, due to caseation of the products of a tubercular osteitis, shows no tendency to self-cure, no organization or sclerosis takes place, and no new bone forms unless an operation is performed. The interior of bones, especially of the carpus and tarsus, is entirely softened and destroyed, and thin shells only are left.

Caries necrotica is a condition in which small but visible portions of soft and dead bone are cast off; *caries sicca* is molecular death of bone without suppuration.

The caseating masses in tubercular caries contain the tubercle bacillus. If a tubercular collection is evacuated and infection with pus organisms occurs, genuine suppuration takes place, and constitutional infection causes septic fever, and may cause death. Purulent osteitis may affect any part of any bone; but caseous osteitis (tubercular caries) tends to arise especially in cancellous structures (heads of long bones, vertebral bodies, ribs and sternum, and bones of the carpus and tarsus). Tubercular osteitis of the shaft of a long bone occasionally, but rarely, arises. Tubercular osteitis is apt to cause tubercular disease in an adjacent joint. Cold abscesses are frequently due to tubercular osteitis. Caries may be followed by amyloid changes in the viscera.

Symptoms.—In the beginning the evidences of caries are usually those of osteitis, but the first sign noted may be a fluctuating swelling due to pus or to caseated tubercles. After a time, at any rate, a fluctuating swelling is discovered. If not opened, the softened mass breaks externally, voids its contents, and leaves a sinus from which flows caseated matter which after a time becomes thin, reddish, and irritating to the skin, contains small portions of gritty bone, and has a foul smell. The opening of the sinus fills up with edematous granulations. A probe carried to the bottom of the sinus finds bone which is sieve-like (worm-eaten), and which on being struck gives a muffled note rather than the clear, sharp note of necrosis; the bone is rough, is bared,

and is so soft that the probe can usually be stuck into it. In old cases of caries amyloid disease may arise.

Treatment.—If syphilis exists, give iodid of potassium in advancing doses and a mild mercurial course. If tubercle exists, give iodid of iron, arsenic, cod-liver oil, and nourishing foods, and recommend a change of air. Locally, in all cases, insist on rest and at once secure drainage, enlarging the opening if necessary and inserting a tube, and even making additional openings; syringe often with antiseptic fluids and dress antiseptically. If the case is seen before spontaneous evacuation has occurred, open under strict antiseptic precautions. When a chronic sinus exists there arises the question of operation. Incomplete operations are worse than useless, for they may be followed by diffuse tuberculosis or pyemia. If the gouge is used, try to remove *all* carious bone. The diseased bone is white, crumbles up, and does not bleed; the non-carious bone is pink and vascular. Scrape away all granulations; swab the cavity with pure carbolic acid and pack it with iodoform gauze. Instead of gouging away bone, there may be used the actual cautery, sulphuric acid, or hydrochloric acid. In severe cases excision is required, and in some rare cases amputation may be necessary. Caries of the spine is considered under Diseases of the Spine.

Necrosis is the death of visible portions of bone from circulatory impediment. It is analogous to gangrene. The cause of necrosis is injury (such as the tearing off of periosteum) which deprives the bone of blood. Inflammation of the periosteum further lessens the nutrition. Acute inflammation in bone causes necrosis, the excessive exudation in the canals and spaces occluding the blood-vessels by pressure. The occlusion of vessels by septic thrombi may lead to necrosis, or the direct action of toxins may first inflame and finally destroy a portion of the bone. A thin shell of bone only may necrose from periosteal separation, or an entire shaft may die from acute pyogenic osteomyelitis or diffuse infective periostitis. Osteomyelitis is the most usual cause of necrosis. Necrosis is most frequently met with in the diaphyses of the long bones, caries in the cancellous tissue of bones. The ribs may become carious, but very rarely become necrotic. A sequestrum may form in a vertebral body, in the carpus, or in the tarsus, but rarely does; hence, we conclude that sequestra do not often result from tubercular osteitis. A fragment of dead bone as a foreign body; the healthy bone adjacent to it inflames and softens;

granulations form, and this line of granulation, like the line of demarcation of gangrene, separates the dead part from the living, the white dead bone being surrounded by the red zone of granulation-tissue. A bit of dead bone is called a "sequestrum," and Nature tries to cast it off. A superficial sequestrum is known as an "exfoliation."

Nature's method of casting off a sequestrum is as follows: suppuration takes place at the line of demarcation, osteitis extends for a considerable distance around this line, the periosteum shares in the inflammation, and new bone forms. A cavity is thus made within by suppuration, and a box or case forms without by ossification, the now entirely loosened sequestrum being so encased that it cannot escape. The pus finds its way through the new bone, and there is presented the condition so often seen by the surgeon—namely, a case of new bone known as the "involucrum," a cavity containing pus and the dead fragment or sequestrum, and a discharging

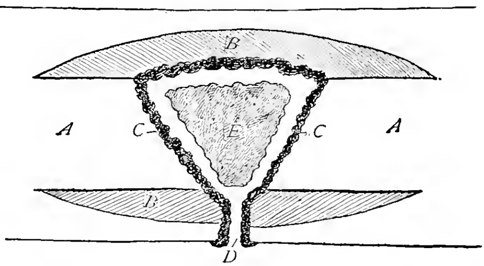


FIG. 108.—Diagram illustrating the formation of a sequestrum: *A*, sound bone; *B*, new bone; *C*, granulations lining involucrum; *D*, cloaca; *E*, sequestrum.

sinus or "cloaca" (Fig. 108). Nature may eventually get rid of the fragment, but the surgeon should not wait for the completion of this slow process.

When a portion of the bone surrounding the medullary canal dies the condition is called "central necrosis." In some rare cases necrosis occurs without apparent suppuration, a painless swelling of bone simulating sarcoma. This condition is known as *quiet necrosis*, and has been described by Sir James Paget and Mr. Morrant Baker. Mercury is an occasional cause of necrosis. The fumes of phosphorus may cause necrosis of the lower jaw in those with decayed teeth. Necrosis may be produced also by frost-bites and burns. Many fevers (measles, typhoid, scarlet fever, etc.) are occasionally followed by necrosis. Syphilis and tuberculosis are occasional causes.

Symptoms.—The symptoms of necrosis are at first those of osteitis or osteomyelitis. The abscess, when formed, opens of itself or is opened by the surgeon, and a sinus or sinuses form in the soft parts as happens in caries. A probe introduced into the sinus strikes upon hard bone with a clear, ringing note, and often finds a sinus or sinuses in the bone. In superficial necrosis the discharge is slight and the probe shows the limitations of the disease. In extensive necrosis the discharge is profuse, much new bone forms, several sinuses appear far apart, and the probe must pass through a considerable thickness of new bone before it finds the bit of dead bone. The surgeon should not operate until the dead bone is separated from the living by a line of demarcation, and until the sequestrum is loose. In youth dead bone loosens quickly, but in old age slowly. An exfoliation becomes loose sooner than the sequestrum of central necrosis. In diffuse periostitis the necrosed shaft loosens quickly. Necrosed portions of the upper extremity loosen more rapidly than those of the lower. Chilton says that in the young adult two or three months will be required to loosen a necrosed fragment in the lower extremity, and from six weeks to two months in the upper extremity. A loose sequestrum may be moved by the probe, and when struck gives a hollow note. In protracted cases of necrosis there is always danger that amyloid disease may arise.

Quiet necrosis is a rare condition which has led to some deplorable but pardonable mistakes, because it resembles ossifying sarcoma. It follows injury, particularly fracture. The bone enlarges greatly. There is little or no pain and no fever. The diagnosis can only be made by exploratory incision, and it may even be necessary to remove portions for microscopic study before a conclusion can be reached.

Postfebrile necrosis is most usually met with after typhoid fever. The bacilli of typhoid cause osteomyelitis, and this is followed by necrosis. Scarlet fever, measles, and other febrile processes may also induce necrosis. It is certain that bacilli accumulate in the bones during typhoid fever. They may promptly induce disease; they may remain for long periods apparently inactive and finally pass away; or after a slight strain or injury these organisms may induce bone disease months or even years after the primary infection. Typhoid bone disease is often multiple, many bones being involved successively.[1] Not unusually after typhoid fever muscle strain causes periostitis and osteitis, and at such a

[1] Keen's *Surgical Complications of Typhoid Fever.*

point necrosis may occur. Either exfoliation, or central necrosis, may follow typhoid fever. The tibia is involved more often than other bones.

Treatment.—An exfoliation should be removed as soon as it becomes loose, the seat of trouble should be touched with pure carbolic acid, and packing of iodoform gauze should be inserted. The treatment of central necrosis comprises free incisions for drainage, antiseptic dressing, frequent cleansing, rest, nourishing food, stimulants, and tonics. When the sequestrum becomes loose the involucrum should be broken through with the chisel, gouge, and rongeur. The dead bone should be removed and the cavity scraped, irrigated with hot salt solution, dried, painted with pure carbolic acid, and packed with iodoform gauze. This operation is known as "sequestrotomy." If much of a gap is left by the operation, the surgeon should try to fill it by taking flaps of skin and fastening them to the bottom with nails (Neuber's operation), by breaking the edges of the involucrum and turning them in, or by inserting bone-chips. Bone-chips are obtained from the compact part of the tibia or femur of an ox, and are decalcified by being placed for a couple of weeks in a 10 per cent. aqueous solution of hydrochloric acid (which is renewed every day); they are well washed in a weak alkali and then in water, are cut into strips, are soaked for two days in a 1 : 1000 solution of corrosive sublimate, and are kept until needed in a saturated ethereal solution of iodoform. The cavity is made sterile and is well dusted with iodoform, the bone-chips are dried and inserted into the cavity, a capillary drain is employed, the periosteum is stitched over the opening, and the soft parts are sutured; but if this cannot be done, iodoform packing is used to keep the chips in place. This method we owe to the genius of Senn. Attempts have been made to fill bone-cavities with gutta-percha, plaster of Paris, etc. (Martin). Schleich uses formalin-gelatin to fill bone-cavities. The difficulty is to completely asepticize the walls of the cavity. Dressman has advised for this purpose the use of boiling oil, but it is apt to cause superficial necrosis. In some cases of widespread necrosis due to diffuse infective osteoperiostitis or to osteomyelitis extensive resection, or even amputation, may be necessary.

Acute osteomyelitis is an acute and diffuse inflammation of the bone-marrow due to pyogenic organisms. Infection from staphylococci may be limited to a portion of one bone. Streptococcus infection causes widespread involvement of a bone or of sëveral bones. Acute osteomyelitis

may be due to mixed infection with bacilli of typhoid and pyogenic organisms, or bacilli of tubercle and pyogenic organisms, a typhoid process or a tubercular process serving to establish a point of least resistance.

The pyogenic organisms may gain entrance directly by way of a wound (a gunshot-wound, a compound fracture, an amputation). The causative organisms may reach the bone by way of the blood, having entered the blood originally through the lymphatic system or from a focus of suppuration in the skin, the subcutaneous tissue, or a deeper part.

Pus organisms may pass into the blood from the tonsils or respiratory organs (Kraske); the intestinal canal (Kocher); the genito-urinary tract; or from excoriations, bruises, or small wounds in the skin (Warren). Certain fevers strongly predispose to the disease by preparing the soil as it were for the growth of pyogenic bacteria. Typhus fever, smallpox, malarial fever, scarlet fever, measles, and diphtheria lessen the vital resistance of bone-marrow. Typhoid fever is not unusually followed by a chronic osteomyelitis, due solely to typhoid bacilli. If mixed infection with pus organisms occurs, acute osteomyelitis arises. Vital resistance of marrow is lessened by exhausting diseases, overexertion, unhealthy and especially putrid food. When organisms gain entrance directly by a wound (as in a compound fracture), the endosteum, the medulla, and the cancellous tissue inflame and suppurate, and the entire length and thickness of the bone may be involved. The periosteum becomes infiltrated, detached from the bone, and retracted from the edges of the wound in the bone. The soft tissues around the bone may inflame, suppurate, or slough. More or less necrosis inevitably occurs.

Acute osteomyelitis without a wound is often called acute epiphysitis or acute infantile arthritis. This condition is most common in infants or children of one to two years of age, but occasionally arises in older children (from ten to fourteen years). It is most common during the period of active growth of bone. It is frequently preceded by one of the predisposing causes before mentioned. In many cases a strain or bruise is followed by pyogenic infection, because the damaged tissue extends a hospitable welcome to micro-organisms which are travelling in the body-fluids and pass through the injured area. In some cases chilling of the surface of the body is a predisposing cause. In others no predisposing cause is discoverable.

The compact bone suffers secondarily, but is never attacked primarily. New tissue is more susceptible to infection than old tissue, and the disease, as a rule, begins near the epiphyseal line, where new bone is being formed. This point was spoken of by Ollier as "the zone of election of pathological processes." Warren points out that in a growing bone near the epiphyseal cartilage there exists a newly-formed spongy tissue, very vascular and connected with the cartilage by a spongy layer of tissue, which is not yet bone, but which does not possess a cartilaginous structure. It is in this portion of the skeleton that the most active changes take place during the period of growth. The medullary substance is very vascular at this point; it is red and without fatty tissue. It communicates with the medullary canal and with the periosteum by a number of vascular channels. The epiphyseal cartilage itself is intimately blended with the periosteum. The diaphyseal side of the cartilage produces much more bone than is found in the epiphyseal margin. There is also an active growth of bone in the periosteum, and it is in these regions and in the medullary canal that the inflammatory process originates.[1] The lower end of the femur and the upper end of the tibia are the regions most commonly attacked; but the upper end of the femur and the lower end of the tibia may suffer, and other bones may be attacked, especially the humerus, radius, ulna, and inferior maxilla. The adjacent joint not unusually becomes involved. Though the inflammation begins in the spongy tissue or medulla, it passes to the canals and spaces of the compact bone. The inflammatory exudate in the canals compresses the vessels and cuts off nutrition from certain areas. Suppuration begins, clots form in the medulla from thrombophlebitis, and the clots in the vessels of the Haversian canals become septic. A small sequestrum forms at the seat of origin of the disease, and the pus about the sequestrum is apt to empty into the medullary canal, causing diffuse osteomyelitis, or into the adjacent joint, causing suppurative inflammation of the articulation.

Marked constitutional symptoms arise from absorption of toxins (sapremia), and sometimes true septic infection or even pyemia arises.

Very extensive necrosis may follow osteomyelitis if the patient recovers.

Symptoms.—Osteomyelitis secondary to a wound may occur in a person of any age. If a wound exists, for in-

[1] Warren's *Surgical Pathology.*

stance a compound fracture, the diagnosis is evident. The constitutional symptoms of septic absorption are positive: there is a profuse, offensive, purulent discharge containing bone-fragments and tissue-sloughs; the periosteum is red, thick, and separated; there are swelling over the bone, great tenderness, and violent boring, gnawing, or aching pain. Osteomyelitis occurring without a wound, the condition known as acute epiphysitis, occurs in the young, and particularly in children under three years of age.

The symptoms of acute epiphysitis usually come on suddenly and especially at night, and the attack may be so acute as to cause death by systemic poisoning before a diagnosis is arrived at. The disease is generally ushered in by a chill, which is followed by septic febrile temperature. The history will sometimes contain the statement that a blow was received, that a febrile process had existed, or that the patient was suddenly chilled after being overheated (sitting in a draft or in a cellar on a hot day, possibly swimming when very warm, etc.). There is violent aching pain in the bone and acute tenderness near the joint; the soft parts, which at first are healthy in appearance, after a time discolor, swell, and present distended veins, and may become glossy and edematous because pus is gathered below. An abscess often reaches the surface and may break spontaneously. The neighboring joint swells, and may become filled with pus; the periosteum and the shaft are involved for a considerable distance; each epiphysis may become affected, the shaft between being comparatively uninvolved, and the epiphyses may separate, displacement and shortening taking place. This disease is often mistaken for rheumatism because of the joint-swelling, occasionally for typhoid fever because of the fever, and in some cases for erysipelas because of the redness of the skin. It gives a very grave prognosis. Sometimes an epiphysitis shows milder symptoms and is slower in progress (subacute). These cases are very often mistaken for rheumatism. But in rheumatism the joint is the part involved from the beginning, while in epiphysitis the joint is involved secondarily after obvious evidence of inflammation well clear of the articulation. Further, the symptoms of rheumatism will be rapidly improved by the use of the alkalies or the salicylates.

Treatment.—If a wound exists, apply a tourniquet, sterilize the parts, enlarge the wound, expose and curet the medullary cavity, remove loose fragments of bone, irrigate the medullary cavity with a hot solution of corrosive subli-

mate or hot salt solution, scrape it, paint with pure carbolic acid, pack lightly with iodoform gauze, dress with hot antiseptic fomentations, and secure rest for the part by splints and bandages. The constitutional treatment is the same as that for septicemia. Acute epiphysitis is a most serious condition, rapidly progressive, apt to be quickly fatal, and requiring prompt and radical treatment. In treating acute epiphysitis do not wait for fluctuation, but incise at once; break through the bone at one or more points with a gouge or chisel; chisel away the diseased bone, and if necessary curet the medullary canal; irrigate with hot corrosive-sublimate solutions or hot salt solution; swab with pure carbolic acid; use iodoform plentifully; pack with iodoform gauze; dress with hot antiseptic fomentations; drain the joint if it is involved; employ rest, anodynes, strong supporting treatment, and other remedies advised in septicemia. Remove dead bone subsequently when it becomes loose. Amputation may be required in either form of the disease.

Chronic osteomyelitis is usually linked with osteitis. It may eventuate in osteosclerosis with filling up of the medullary canal, in limited suppuration, in caseation of the cancellous tissue (Brodie's abscess), or in necrosis. A tubercular inflammation is one form of chronic osteomyelitis. Syphilis, typhoid fever, etc., may cause it.

The typhoid bacillus is pyogenic. Fränkel taught this some years ago, and Keen seems to prove it in his work on the surgery of typhoid fever. Osteomyelitis due purely to typhoid bacilli is chronic. When the medulla contains typhoid bacili pus infection is apt to take place, and if such a mixed infection arises acute osteomyelitis develops.

In chronic osteomyelitis there are pain, tenderness, and swelling, but no constitutional symptoms. In some cases the real trouble is not identified until an abscess forms (see Necrosis).

Treatment.—Evacuate an abscess and remove dead bone.

Osteomalacia, or Mollities Ossium.—In this disease the bones are partly decalcified, and consequently soften and bend. Many bones are usually involved. It is commoner beyond than before middle age, though it may occur in infancy; it is more frequently met with in women than in men, and pregnancy seems to bear more than a casual relation to its production. In osteomalacia the medulla increases in bulk and becomes more fatty, and the osseous matter is absorbed gradually, first from the cancellous tissue and then

from the compact tissue. Some observers believe this curious condition is due to lactic acid in the blood.

Symptoms.—The symptoms of osteomalacia are as follows: many points of pain which are often thought to be due to rheumatism; deformities from twisting and bending of bone; and a large excess of calcium salts in the urine. This disease lasts a number of years, but usually causes death from exhaustion, though some few cases are arrested or cured. Fractures occur from very slight force.

Treatment.—In treating osteomalacia in women insist that pregnancy must not occur. Put braces and supports upon distorted limbs to prevent fracture. Advise good air, hygienic surroundings, and nourishing food. Among the medicines that can be used may be mentioned cod-liver oil, lime salts, preparations of phosphorus, and bone-marrow. In women the removal of the ovaries sometimes produces cure. It has been asserted that the production of anesthesia by means of chloroform may be of benefit.

Acromegaly.—This is a disease which causes progressive and often great enlargement of both the bones and soft parts of the extremities, which enlargement is symmetrical. The lower jaw projects in advance of the upper jaw, the nose becomes prominent and thick, the supraorbital ridges are accentuated, and the costal cartilages and inner ends of the clavicles become protuberant. Later the larynx, ribs, shoulder-blades, and vertebræ become involved, and the back becomes markedly humped (cervicodorsal hump). The hands and feet are affected in advanced cases. As a rule, the thyroid gland is enlarged, and a post-mortem examination may detect an enlarged pituitary gland. Severe and uncontrollable headache is sometimes a distressing feature of the disease. Treatment is futile. The disease slowly but surely causes death.

Leontiasis Ossium (Virchow's Disease).—This is a hypertrophy limited to the facial and cranial bones, which is symmetrical, and which begins, as a rule, in the superior maxillæ. The hypertrophy progressively increases, causes difficulty of mastication, and is accompanied by headache. It produces distinct deformity of the jaw like a tumor, whereas acromegaly enlarges all of the proportions of a bone. Treatment is not satisfactory, as a rule. Recently Horsley has obtained amelioration by operating and removing masses of bone.

2. Fractures.

Definition.—A fracture is a solution, by sudden force, of the continuity of a bone or of a cartilage. Clinically, under this head are placed epiphyseal separations and the tearing apart of ribs and their cartilages.

Varieties of Fractures.—The varieties of fractures are as follows:

Simple fracture is a subcutaneous fracture, or one in which there is no wound extending from the surface to the seat of bone-injury. This corresponds to a contusion of the soft parts.

Compound fracture is an open fracture, or one in which an open wound extends from the surface to the seat of bone-injury or in which a wound opens up a passage from the fracture to the surface. This corresponds to a contused or lacerated wound of the soft parts. The opening may be through the skin; through a mucous membrane, as in some fractures of the base of the skull and pelvis; through the drum of the ear, as in some fractures of the middle fossa of the base of the skull; through the lung, as when a broken rib penetrates that organ; or through the bowel or bladder, as in some fractures of the pelvis.

A primary compound fracture is one in which the breach in the soft parts is produced at the time of the accident, either by the direct violence of the injury or by the forcing of a bone or bones through the tissues.

A secondary compound fracture is one in which the breach in the soft parts occurs after the accident, either from sloughing of damaged tissues, from ulceration because of the pressure of ill-adjusted fragments, or from the forcing of a bone or bones through the soft parts because of rough handling, neglect, or the tossing of delirium.

Complicated fracture is a fracture plus the complication of a joint-injury, arterial or venous damage, or injury to the nerves or soft parts. When a fractured rib injures the lung or when a broken vertebra damages the cord a complicated fracture exists. The term is unfortunate, as it conveys no definite meaning, and its use is no more justifiable than it would be to speak of "complicated pneumonia" or "complicated typhoid," for the complication should be named in any case. It must be remembered that damage to the soft parts not sufficiently severe to produce a wound reaching from the surface to the seat of fracture does not make the case a compound fracture, but rather

complicates a simple fracture. Remember also that even superficial areas of tissue-destruction must be treated antiseptically, otherwise absorption of pyogenic bacteria and their deposition at the seat of injury may cause diffuse osteomyelitis.

Complete fracture is that which extends through the whole thickness of a bone or entirely across it.

Incomplete fracture is that which extends only partially through the thickness of a bone or only partially across it.

A linear, hair, capillary, or *fissured fracture*, or *a fissure*, is a crack in a bone with very little separation of the edges. This is an incomplete fracture, but may be associated with a complete break.

A green-stick, hickory-stick, willow, or *bent fracture* is a true incomplete break. It is commonest in the forearm and clavicle, it arises from indirect force, and it is very rare after the age of sixteen. It is called "green-stick" because the bone breaks like a green stick when forced across the knee, first bending and then breaking on its convex surface. The bone, being compressed between two forces, bends, and the fibers on the outer side of the curve are pulled apart, while those on the concavity are not broken, but are compressed. In correcting the deformity such fractures are often made complete. The permanent bending of a bone without a break may possibly occur in youth. In children a portion of a bone of the skull may be bent inward, causing depression. In some cases such a depression is permanent; in others it is temporary, the bone returning to its proper level.

Depression-fracture occurs when a portion of the thickness of a bone is driven in by crushing. Fracture by depression is a result of the bending in of a bone (as the parietal), a fragment breaking off from the side toward which the bone is bending. A *depressed fracture* is complete, not incomplete, and by this term is meant an injury in which a fragment of the entire thickness of the bone is driven below the level of the surrounding surface.

Splinter- and Strain-fracture.—The breaking off of a splinter of bone (splinter-fracture) or of an apophysis constitutes a form of incomplete fracture. A strain upon a ligament or a tendon may tear off a shell of bone, and this injury is the "strain-fracture" or "sprain-fracture" of Callender.

Longitudinal fracture is a fracture whose line is for a considerable distance parallel, or nearly so, with the long axis of the bone. Such fractures are common in gunshot-injuries.

Oblique fracture is a fracture the direction of which is pos-

itively oblique to the long axis of the bone. Most fractures from indirect force are oblique.

Transverse fracture is a fracture the direction of which is nearly transverse to the long axis of the bone (no fracture is mathematically transverse). The cause is often but not invariably direct force. The "*fracture en rave*" (radish-fracture, so called because the bone breaks as does a radish) is transverse at the surface, but not within.

Toothed or *dentate fracture* is a form of fracture in which the end of each fragment is irregularly serrated and the fragments are commonly locked together; hence it is difficult to correct the deformity. Most simple fractures from direct force are serrated.

Wedge-shaped, *V-shaped*, *cuneated*, or *cuneiform fracture* ("fracture oblique spiroïde," "fracture en V" of Gosselin, "fracture en coin") is a fracture the lines of which take the shape of a V, which may be entire or may lack the point. It occurs at the articular extremity of a long bone, and a fissure usually arises from its point and enters the joint. If complete, it is a "comminuted fracture."

T-shaped fracture is a fracture which presents a transverse or oblique line and also a longitudinal or vertical line. It occurs at the lower end of either the humerus or femur, the transverse line being above, and the vertical line (intercondyloid) between, the condyles. If complete, it is in reality a form of comminuted fracture.

Multiple or *composite fracture* is a condition in which a bone is broken into more than two pieces, the lines of fracture not intercommunicating, or a condition in which two or more bones are broken. Multiple fractures of one bone are divided into double, treble, quadruple, etc.

Comminuted fracture is a condition in which a bone is broken into more than two pieces, the lines of fracture intercommunicating. The bone may be broken into many small fragments, there may be much splintering, or the osseous matter may actually be ground up.

Impacted fracture is one in which one fragment is driven into the other and solidly wedged.

Fracture with crushing or *penetration* is a fracture in which one bone is driven into the other, the encasing bone being so splintered that the impacting bone is not firmly held.

Pathological, *spontaneous*, or *secondary fracture* is one occurring from a very insignificant force acting on a bone rendered brittle by disease.

Ununited fracture is a term used to designate a fracture

in which bony union is absent after the passage of the period normally necessary for its occurrence.

Direct fracture is one occurring at the point at which the force was primarily applied.

Indirect fracture is one occurring at a point distant from the area of the primary application of force.

Stellate, or *starred, fracture* (fracture par irradiation) is one in which several fissures radiate from a center. If the fractures be complete, the condition is in reality a form of comminuted fracture.

Helicoidal, spiral, or *torsion fracture* is a fracture resulting in a long bone from twisting.

Fracture by contrecoup is a fracture of the skull which is on the opposite side of the head to that which was the recipient of the force.

Epiphyseal Separation or Diastasis.—This injury occurs only before the age of twenty-five and is commonest at the lower end of the femur, but it is encountered also at the lower ends of the tibia and radius and at both extremities of the humerus. This injury induces deformity, which is often difficult to reduce, and by damaging the cartilage may retard or inhibit a further lengthening of the limb by growth.

Intra-uterine fractures are usually due to injuries of the mother's abdomen sustained toward the end of pregnancy. Some hold that they can arise as a consequence of the force of violent uterine contractions. Many so-called "intra-uterine" fractures are wrongly named, as they result from injury during delivery. In sporadic cretinism the bones are fragile and ill-ossified, and many fractures may occur *in utero*.

Designations According to Seat of Fractures.—Fractures are designated also according to their anatomical seats; for instance, fracture of the upper third of the shaft of the femur, fracture of the olecranon process of the ulna, fracture of the middle third of the clavicle, and fracture of the body of the lower jaw. *Intra-articular* fracture is one extending into a joint; *intracapsular* fracture is one within the capsule of either the shoulder- or hip-joint; and *extracapsular* fracture is one just without the capsule of either the shoulder- or hip-joint.

Causes of Fracture.—The causes of fracture are (1) exciting, immediate or direct, and (2) predisposing or indirect.

Exciting causes are (*a*) external violence and (*b*) muscular action.

External violence is the most usual exciting cause. Two forms are noted: (1) direct violence and (2) indirect force.

Fractures from direct violence occur at the point struck, as when the nasal bones are broken with the fist. In such fractures the soft parts are damaged; they may be destroyed at once in part, they may be damaged so severely that a portion sloughs, or they may be damaged so slightly that they do not lose vitality; hence fractures by direct violence may be compound from the start, may become so, or may remain simple. In fractures by direct force discoloration, due to effused blood, usually appears at the point struck soon after the accident. In compound fractures by direct violence the soft-part injury is so great that primary tissue-union cannot occur.

Fractures from indirect force do not occur at the point of application of the force, but at a distance from it, the force being transmitted through a bone or a chain of bones, as when the clavicle is broken by a fall upon the extended hand. Such fractures tend to occur in regions of special predilection. If they are not compound, there is no injury of the surface over the fracture. If they become compound by projection of fragments, primary union may still occur. Discoloration over the seat of fracture is usually not present soon after the accident, but may occur later. Discoloration rapidly appears in soft parts at the point where the force was first applied.

Muscular action is a rather rare cause. Fractures thus produced result from sudden or violent contraction. Bones so broken are usually diseased. Violent coughing may fracture the ribs; attempting to kick may fracture the femur; saving one's self from falling backward may fracture the patella; throwing a stone may fracture the humerus; and sudden extension of the forearm may fracture the olecranon process of the ulna.

Predisposing Causes.—There are two classes of predisposing causes, namely: (1) physiological, natural or normal, and (2) pathological or abnormal.

Natural Predisposing Causes.—Under this head is considered the liability to fracture possessed by individual bones because of their shape, structure, function, or position. Those predispositions occasioned by special ages are also considered. In youth epiphyseal separation is commoner than fracture, and a fracture is apt to be incomplete. Fractures are commonest between the ages of twenty-five and sixty. From two to four years of age a child is more liable to fracture than later, because he is then learning to walk (Malgaigne). The bones of the old are easily broken, but the normal lack of activity of the aged saves them from more frequent injury.

Thus the predispositions of age are in part due to habits and in part to bony structure. The bones of the young, being elastic, bend considerably before they break; the bones of the old, being brittle and inelastic, break easily, but do not bend. In old age the bones become lighter and more porous, though they do not diminish in size. An absorption takes place from the interior of a bone, particularly at its articular head, the medullary canal increases in size, the cancellous spaces become notably larger, and portions of the remaining bone of the interior show a fatty change. There is no increase in the amount of mineral salts present, as was long taught. These alterations occur earlier in women than in men.[1] The change of age is a diminution in the amount of bone present, and sometimes a fatty change in a portion of what remains. If the atrophy of bone is other than that normal to senility, it constitutes a pathological predisposing cause of fracture. Normal predisposing causes include the person's weight (which determines the force of a fall), muscular development, habits, sex, occupation, and the season of the year.

Pathological Predisposing Causes.—Hereditary fragility is a condition commonest among women, often existing in generation after generation, and in this condition fractures occur from a very slight force. There exists in these cases bony rarefaction—in fact, a premature senility.

Nervous Diseases.—Bony nutrition is dependent on the spinal cord, and the trophic influence is probably exerted through the posterior nerve-roots (Gowers). In diseases of the anterior cornua bony growth is much interfered with; in diseases of the posterior columns, as in locomotor ataxia, a true bony atrophy bespeaks trophic disorder. Syringomyelia causes brittleness of the osseous structures, and in paralysis agitans bones are thought to break easily. Trophic changes may occur in the bones of the insane, most commonly when insanity is linked to organic disease. About one-quarter of paretic dements show undue brittleness or unnatural softness of bones.[2] The bones of maniacs are frequently fragile. Fractures among the insane are not necessarily an indication of abuse.

Rickets.—Rickets predisposes to fracture because of altered bone-structure and the great liability to falls.

Atrophy of Bone.—This condition, as has been seen (p. 389), is normal in senility. It may arise from want of use, as is observed in the bedfast, in the wasted femur of

[1] Humphrey on *Old Age*. [2] *Manual of Insanity*, by Spitzka.

hip-joint disease, and in the bones of a stump. It may arise from pressure, as when an aneurysm compresses the ribs, sternum, or vertebræ. Among other of the pathological predisposing causes are to be mentioned cancer, sarcoma, hydatid and solitary cysts of bone, caries, necrosis, gout, scrofula, syphilis, mollities ossium, and scurvy.

Symptoms of Fracture.—*History of an Injury.*—In spontaneous fracture there may be no record of violence; for instance, a bone may break while an individual is turning in bed. In investigating the history, not only seek for a record or for evidences of violence, but try to determine exactly how the accident happened.

A sound of cracking is occasionally audible to a bystander at the time of the injury. The patient may have heard it, but very rarely does. A rupture of a tendon or a ligament produces a similar sound.

Pain is usually, but not invariably, present (absent often in rickets). Malgaigne says that in some fractures the pain is slight or absent, in others it is torturing, and in most it is severe for a time after the injury, but gradually abates unless reinduced by movement. Pain developed at the time of the accident is far less important as a symptom than that which can subsequently be produced by movement. In indirect fracture there is an area of pain at the point of application of the force, and another at the seat of fracture. Pain at the seat of fracture can be greatly aggravated by pressure or movement and is rather narrowly localized.

Deformity or *alteration in length or outline* is due in part to swelling and in part to a change in the mutual relation of the fragments (displacement). The deformity due to swelling is no aid to diagnosis, as the same condition occurs in contusion, and often hides some positive symptomatic distortion. The swelling is due first to blood and next to inflammatory products and pressure-edema, and is very great in joint-fractures. The deformity of displacement may be produced by the violence of the injury (as is the depression in a skull-fracture), by the weight of an extremity (as is the falling of the shoulder in a fracture of the clavicle), or by muscular action (as is the pulling upward of the superior fragment of a fractured olecranon process).

The **varieties of displacement** are (1) *transverse* or lateral, where one fragment goes to the side, front, or back, but does not overlap the other; (2) *angular*, the bony axis at the point of fracture being altered and the fragments forming with each other an angle; (3) *rotary*, one fragment

rotating in the bony circumference, the other remaining stationary. As a rule, it is the lower fragment which turns on its long axis, the limb below the level of the break rotating with it; (4) *overlapping* or overriding, when the upper level of one fragment is above the lower level of the other fragment. It is usually the lower fragment which is drawn by the muscles above the upper, but in a fracture of the lower extremity the body-weight and sliding down in bed may push the upper below the lower fragment. In overriding the ends are near together and the bones are usually in contact at their periphery. It is obvious that overlapping is associated with transverse displacement, as one fragment must go front, back, or to the side; (5) *penetration* or impaction is when one fragment is driven into the other, thus producing shortening; (6) *separation* of the two fragments occurs in fracture of the patella, olecranon, os calcis, certain articulations, and in some breaks of the humerus when the arm is not supported.

It is important to remember that a dislocation as well as a fracture may produce displacement, but these two conditions may be differentiated by the observation that the displacement of fracture tends to reappear even after complete reduction, while the displacement of dislocation does not reappear after correction. A displacement is difficult of detection in a flat bone and when one of two parallel bones is broken.

Loss of function may be shown by inability to move the limb because of the break, but it is not always markedly present, though some degree invariably exists. It is slight in "green-stick" and impacted fractures (unless the loss of power arises from pain or nerve-injury). A person can walk when the fibula alone is broken, and likewise in some cases of intracapsular fracture of the femur, and can often put the hand on the head in fractured clavicle (Malgaigne). The pain of any injury or the loss of power from nerve-traumatism may cause loss of movement in the limb. This symptom is of slight diagnostic value in most fractures.

Extravasation of Blood.—A contusion of the surface accompanied by skin-abrasion indicaties merely the point of application of direct external violence. If contusion is extensive over a superficial bone, as the tibia or parietal, after a few hours it often stimulates fracture by presenting a soft, compressible center surrounded by a ring of hard, condensed tissues and coagulated blood. Direct external violence may merely occasion ecchymosis, and in fracture from indirect force ecchymosis may occur throughout a considerable area.

In regard to this symptom, note that even great external violence may occasion no evident contusion or ecchymosis, and in any fracture this symptom may be present or absent. In old people, anemic subjects, alcoholics and opium-eaters, extravasation of blood is frequently marked and persistent. By suggillation is meant an extravasation of blood which slowly invades wide areas of tissue and which appears at the surface only after some time, and then usually as a yellowish discoloration, red hemoglobin having been changed to yellow hematoidin. Linear ecchymosis has been esteemed by some as a sign of fissure, and it is often noted after fracture of the fibula. Linear ecchymosis over the line of the posterior auricular artery was shown by Battle to be a valuable sign of fracture of the posterior fossa of the base of the cranium.

Preternatural mobility is a most important symptom, which is pathognomonic when surely found. The unbroken bone is nowhere mobile in continuity. By preternatural mobility is meant that a bone is mobile in continuity or that there is abnormality in the direction or extent of joint-mobility. In some fractures this symptom does not exist (impacted, green-stick, and locked serrated fractures); in others it cannot be found (fractures of tarsus, carpus, vertebral bodies); in others it is difficult to obtain, but at times can be developed (fractures near or into many joints). To develop this symptom, try, when the case admits, to grasp the fragments and to move them in opposite directions. In a fracture of the shaft of the femur or humerus fix the upper fragment and carry the knee or elbow in various directions to develop bending at the point of fracture. In fracture of the clavicle push the shoulder downward and inward. In fractures of either bone of the forearm grasp the opposite bone with four fingers of each hand and make pressure on the suspected bone alternately with either thumb, and the same procedure can be used in fractures of the leg. In fracture of the neck of the femur note the rotation-arc of the great trochanter (Desault). In fracture of the lower end of the radius bend the hand back, and in a break of the lower end of the fibula evert the foot (Maisonneuve). In seeking preternatural mobility, remember that the elastic ribs when being forced in give a sense of bending, and that the fibula at its middle is "normally flexible" (Dupuytren). Some rachitic bones may be bent.

Crepitus or *crepitation* is both a sensation and a sound, which indicates the grating together of the two rough surfaces of a broken bone. This symptom is of great value, but it is not always present. It is absent in locked serrated

fractures, in impacted fractures, in cases where the broken ends cannot be approximated (as in overlapping), is rare when a fractured sürface is against the side, and not the broken face, of the other fragment, and is unusual in incomplete fractures. Crepitus is often absent in epiphyseal separation, in softened bones, and in fractures in or near joints, and it may be prevented from occurring by blood-clot, fascia, or muscle between the broken surfaces. The grating found in tenosynovitis must not be mistaken for the crepitus of fracture: the former is diffuse, large, soft, and moist; the latter is limited, small, harsh, and dry. The clicking of an inflamed or eroded joint and the cracking of emphysema must also be separated from bony crepitus. Crepitus of fracture may be present at one moment, but absent the next. It is often not detected during the time swelling is marked, and cannot be discovered after organization of the callus begins. In but few fractures is it needful to try to hear crepitus with the naked ear or with a stethoscope upon the part, but in doubtful cases of fractures of ribs and joints this evidence should be sought for.

The above-named symptoms are known as "direct." There are other symptoms known as "circumstantial," such as the flow of blood and cerebrospinal fluid from the ear after some fractures of the middle fossa of the skull; emphysema of the face and epistaxis after fracture of the nasal bones; hemoptysis and emphysema after crushes of the chest; discoloration following the line of the posterior auricular artery after fracture of the posterior fossa of the skull; and subconjunctival ecchymosis after fracture of the anterior fossa of the skull.

Diagnosis.—Examine as soon as practicable after the injury—before the onset of swelling, if possible. Expose the part completely, taking off the clothing, if necessary, by clipping it along the seams. Attentively scrutinize the part and compare it with the corresponding part on the opposite side. If any deformity be present, it must be ascertained that it did not exist before the accident. If the nature of the injury be uncertain, if the patient be very nervous, or if the part be acutely painful, it is better to give ether to diagnosticate, set and dress. In injuries of the elbow-joint always anesthetize before examination, unless an *x*-ray apparatus is accessible to settle the diagnosis, and even then it is usually well to anesthetize in order to facilitate reduction and dressing.

A fracture is distinguished from a dislocation by its preter-

natural mobility, its easily reduced but recurring displacement, and its crepitus, as against the preternatural rigidity, the deformity, difficult to reduce, but remaining reduced, and the absence of crepitus of a dislocation. Further, in dislocation the bone, when rotated, moves as one piece, whereas in fracture it does not so move; in dislocation the bony processes are felt occupying their proper relations to the rest of the same bone, while in fracture some of them present altered relations; in dislocation the head of the bone is found out of its socket, but in fracture it is felt in its place. It is important to remember, moreover, that a fracture and a dislocation may occur together, and that the rubbing of a dislocated bone against an articular edge, when the joint has been roughened by inflammation, simulates crepitus.

Great contusion, by inducing extreme tumefaction, may mask characteristic deformity and obscure crepitus. When only a contusion exists pain is apt to be widespread; but if a fracture has occurred, the pain is accentuated at some narrow spot. In many cases, before he can give a certain opinion, the surgeon must wait some days until the swelling has largely subsided. In such a case it is best to assume in our treatment that a fracture exists until the contrary is known. Combat swelling by rest, the use of evaporating lotions, and moderate compression.

In impaction the diagnosis is difficult. The moderate deformity is concealed by swelling; crepitus and preternatural mobility do not exist unless the fragments are pulled apart, and there is not necessarily much loss of function. A conclusion is reached largely by considering the nature, direction, and extent of the violence, the seat of the pain, and by a careful study of the most minute deformity. It is difficult to recognize fissures. They rarely present any evidence of their existence except a localized pain, and possibly a linear ecchymosis appearing after a few days.

In green-stick fractures the age, the deformity, and possibly crepitus during reduction help in the diagnosis. Epiphyseal separations are diagnosticated by the age, the preternatural mobility, the deformity, the situation of the injury, and the absence of crepitus or the presence only of a soft crepitus. Fractures are often difficult to recognize when occurring in a group of bones like those of the carpus and tarsus (which are firmly joined by dense ligaments) or in one of two parallel bones. There is not always a certainty that a fracture exists, and when, after a careful examination, there is still an uncertainity, do not prolong the efforts or use great force, but

treat the case as a fracture until a cure ensues or the diagnosis becomes apparent.

We have recently had added to our resources a method of incalculable value in diagnosticating fracture; that is, the use of the force known as the *x*-ray or the Röntgen ray. We can look through a part with a fluoroscope and see the bones as shadows, or we can take a negative of the shadows and print skiagraphs from it. This method is applicable even when the parts are swollen, and even when a limb is clothed or wrapped in dressings. It is possible to obtain a picture of a fractured skull after long exposure; fractured ribs and vertebræ can be detected; and the process is of the greatest use in detecting fractures of the limbs. In order to obtain certain results the *x*-rays must be used by an expert. This method should, if possible, be resorted to in doubtful cases.

Complications and Consequences.—Some of the consequences and complications of fractures are—sloughing of the soft parts, thus making the fracture compound; extravasation of blood, causing swelling or even gangrene; rupture of the main artery or vein of the limb; dislocation; edema from pressure of extravasated blood, from inflammatory exudation, from tight bandaging, from thrombosis, or, later, from the pressure of callus; stiffness of joints from synovitis with adhesion, from displaced fragments, or from intra-articular callus; stiffness of tendons from adhesive thecitis or from the pressure of callus; paralysis from traumatic neuritis or the pressure of callus upon nerve-trunks; muscular spasm; painful callus; exuberant callus; embolism; fat-embolism; pulmonary congestion; gangrene; shock; septicemia; pyemia; tetanus; delirium tremens; urinary retention; extensive laceration of the soft parts; rupture of large nerves; and involvement of joints.

Repair of Fractures.—**Simple Fracture.**—In a simple fracture the bone is broken, the medullary contents are lacerated, the periosteum is torn, and the overlying soft parts are damaged to a considerable degree. The periosteum is stripped more or less from each fragment, but it is rarely completely torn through, an untorn portion known as the *periosteal bridge* remaining. The amount of blood effused is usually considerable, and it forms a decided prominence at the seat of fracture; it gradually gathers because of oozing, and soon clots. This clot lies in the medullary canal, between the fragments, under the periosteum at the ends of the fragments, and in the tissues outside of the periosteum. Very rapidly after the accident the damaged parts inflame

(bone, endosteum, periosteum, and other periosseous structures). The inflammatory exudate enters into the blood-clot and the leukocytes eat up and destroy the clot. The clot is simply dead material and in no way contributes to repair. The cells of the damaged tissue proliferate and the young proliferating cells (embryonic tissue) enter into the spaces in the blood and clot eaten out by the leukocytes. Finally the entire clot is replaced by embryonic tissue, which quickly becomes vascularized (granulation-tissue).

Granulation-tissue is changed into fibrous tissue and then into bone, only the tissue springing from the periosteal bridge going through a cartilaginous stage. The mass of new tissue around and between the bone-ends is called callus. It will be observed that the name is applied successively to embryonic tissue, granulation-tissue, fibrous tissue, and bone. Warren tells us that callus has no well-defined outline, and " involves not only the bone and periosteum, but also the connective tissue and some of the surrounding muscular tissue." Within a few days after the injury the inflammatory mass is much firmer than follows inflammation involving other structures, and the bone-ends are deeply imbedded in a dense mass.

During the second week the callus is greatly strengthened by the formation of dense fibrous tissue in and below the periosteum, of less dense fibrous tissue outside of the periosteum, and of cartilage from the periosteal bridge. The newly formed tissue contracts decidedly. During the third week ossification begins at the points farthest from the fracture, and in the course of a short time (from three to six weeks) is complete. The mass of ossified callus, or new bone, is spindle-shaped and spongy.

The term *intermediate*, *definitive*, or *permanent* callus is used to describe the material which forms between the fractured ends. The name *provisional* or *temporary* callus is given to the material within the canal (central callus) and external to the bone (ensheathing callus). The amount of provisional callus depends directly on the extent of separation and the amount of motion between the fragments. It is Nature's splint, and when the break is not well immobilized a large amount is formed. The greater the amount of motion, short of a degree sufficient to cause non-union, the larger the amount of provisional callus.

The ensheathing callus is after a time largely absorbed, and the central callus in the course of a long time may also be absorbed, with the restoration of the medullary canal,

although this latter result is rare. An excessive amount of provisional callus may ossify nearby tendons, may unite two parallel bones (radius to ulna—tibia to fibula—a rib to its neighbors), may block a joint just as a stone in the crack of a door will block a door, or may absolutely abolish a joint. Fragments, even if entirely detached, often unite, but they may be surrounded by provisional callus; sometimes they do not cause trouble, but sometimes suppuration takes place. It takes about one year for Nature to remove the temporary callus. The definitive or permanent callus after a time ceases to be porous and becomes very dense bone. If callus does not pass beyond the fibrous state, there exists that form of ununited fracture known as "fibrous union."

Compound fractures without much destruction or bruising of soft parts, if treated antiseptically, become at once simple fractures and unite as such. If the wound is not drained and asepticized and septic inflammation occurs, pus forms, and union by granulation is the best that can be obtained. Compound fractures by direct violence will not heal by first intention because of the extensive loss of vitality of a large area of the soft parts.

Delayed union may be due to ill-health, want of approximation, etc. (any of the causes mentioned under Non-union). It is not non-union, but may eventuate in non-union.

Non-union of Fractures.—An ununited fracture is a fracture in which union is not effected at all or in which it is not brought about by bone. The causes are local and constitutional. The *local causes* are (1) want of approximation of fragments (a frequent cause of want of approximation is interposition of soft tissues, especially muscle); (2) want of rest; (3) want of blood-supply (as seen in the heads of humerus and femur, or when a nutrient artery is torn, or when a thrombus forms in a vein near the fracture); (4) defective innervation; and (5) bone-disease. The *constitutional causes* are debility, scurvy, Bright's disease, syphilis, etc. In this condition the broken ends of the bone round off and the medullary canal in each fragment becomes closed by bone. The fragments may not be held together by any material, or they may be held by very thin and much-stretched fibrous tissue (*membranous* union), or by strong, thick, fibrous tissue (*ligamentous* or *fibrous* union). When the ends of the bones come together, are held by a fibrous capsule, and move on each other, there exists a *false joint* or *pseudarthrosis*. Such a joint may after a time secrete serous fluid for lubrication.

Vicious union is union with great deformity, and is often

productive of pain and loss of function. It arises from failure to coaptate the fragments, from a recurrence of displacement after reduction, or from yielding of callus after the removal of splints.

Treatment of Fractures.—If a man is found in the street with a fracture, further injury must be prevented by applying, after cutting off the clothing over the fracture, some temporary support. If an ambulance or patrol-wagon cannot be obtained, move the patient by hand. If the lower extremity be involved, an improvised stretcher (a board or a shutter) is placed on the ground beside the patient, who is placed on the stretcher, the surgeon lifting the injured limb, and the patient is then carried to the hospital and carefully transferred to a fracture-bed, or, if taken home, to a small ordinary bed, a board being placed beneath a rather hard but even mattress. The temporary appliances are now removed and a diagnosis by the methods before given is proceeded with. After determining the nature of the injury the fragments must be adjusted. This should, if possible, be done at once, because a fracture remaining unreduced may become compound, the fragments may injure important structures, and they are sure to cause intense pain. Reduction is easily effected during shock, as the muscles are in a state of relaxation. If there is great swelling, reduction may be impossible, and the part must then be supported and moderate cold, sorbefacients, and gentle pressure used, avoiding ice and tight bandaging, which predispose to gangrene. Set the fracture at the first possible moment. Velpeau's axiom was to reduce fractures at once, regardless of pain, spasm, or inflammation, as reduction is their cure.

If the patient is very nervous, if the pain is severe, or if rigid muscles antagonize the efforts, then reduce the fracture under anesthesia. In some fractures (as those of the clavicle) adjustment is effected by altering the position, and in others (as those of the femur) by extension and counterextension; in some by tenotomy, and in some by kneading, bending, and coaptation. When extension is employed, always endeavor to get a point of counterextension. The extension is to be made on the broken bone (if possible, in the axis of the bone), is to be steady, and neither jerky nor violent. In some cases complete reduction is impossible. This may be due to spasm, to swelling, to the catching of soft parts between the fragments, to the existence of a loose fragment, to locking, or to impaction. An impaction by rotation can generally be released, but it is sometimes undesirable to

reduce it. If the fragments cannot be adjusted without violence, retain them in the best attainable position, combat the antagonistic cause, and set them properly as soon as possible.

After adjusting the fragments they must be maintained in position by some retentive apparatus. Avoid pressure over joints or bony prominences, and particularly guard against tight or improper bandaging. The circulation in the fingers or the toes must be observed as an index of circulation in the limb; hence leave those digits exposed. A retentive apparatus should prevent the re-occurrence of deformity, and not be itself productive of pain or harm. For the first few days of treatment of a simple fracture the dressing is removed every day, to make sure that deformity has not recurred, and if it does recur the fragments must at once be reset. The splints should be padded thoroughly, especially when over joints or bony prominences, and they should, if possible, fix the joints immediately above and below the break. A primary roller should *never* be used.

Some surgeons at once apply an immovable dressing. This proceeding is safe in simple fractures without much displacement or soft-part injury. This dressing is valuable in military practice, for the old and feeble whom we fear to put to bed, for the young who are very restless, and for the insane or the delirious. If, however, there is great deformity, much soft-part injury, or marked swelling, immovable dressings may induce sloughing, edema, gangrene, or faulty union. In the above-named cases use splints for the first few days; then, if it is desirable, the immovable dressing can be applied. It is dangerous to keep old or feeble persons long in bed, as they are prone to develop bed-sores and hypostatic pulmonary congestion. The period for the artificial retention of the fracture varies with the seat of the fracture and the age and the condition of the patient. Passive motion is to be made in most fractures in from two to three weeks, though it is sometimes made earlier to prevent ankylosis. Landerer strongly advocates massage, believing that it hastens union and prevents wasting. He applies it as soon as there is no danger of the callus bending (in from eight to fourteen days). Massage should not be used when great edema points to the possibility of venous thrombosis. The movements might break up a clot and cause fatal embolism.[1] Very early massage may cause fat-embolism. In fracture of the patella, Barker and many others believe in

[1] Cerne's case, in *Normandie méd.; Bull. méd.*, 1895, No. 44.

wiring, and some surgeons advocate the same procedure in fracture of the clavicle and fracture of the tibia.

The plan known as the ambulatory treatment of fractures of the lower extremities has many advocates. Its aim is not only to get the patient about on crutches, but also to cause him to use the limb. It is held that this plan of treatment greatly lessens the patient's sufferings and actually favors union by the stimulation of walking. Bardeleben, in his report to the German Surgical Congress, gave the records of 111 fractures of the lower extremity thus treated (77 simple and 12 compound fractures of the leg; 17 simple

FIG. 109.—Ambulatory dressing of plaster-of-Paris for fracture of the bones of the leg (Pilcher).

FIG. 110.—Ambulatory dressing apparatus for fracture of thigh (Harting).

and 5 compound fractures of the thigh). The patients were gotten about a few days after the accident, were able to attend to business, had excellent appetites, digested their food perfectly, slept well, and were saved from muscular atrophy. Pilcher has warmly advocated the method. It

can be used in fractures as high up as the middle of the femur. The apparatus which we should employ in the ambulatory treatment reaches below the sole of the foot, and is supported firmly above the seat of fracture, the weight of the body being transferred from above the fracture to the firm pad below the sole of the foot on which the patient walks (Fig. 110). This appliance in a fractured thigh is put on about one week after the infliction of the injury. While the patient sits on the ischial tuberosities extension is made upon the leg. The seat of fracture is encircled with a thin plaster cast. The sole of the other foot is raised by a cork sole. Albers uses plaster-of-Paris strengthened by bits of wood, running from *below* the sole of the foot to the iliac crest, when he treats a fractured thigh. Krause says in fracture of the ankle carry the dressing to the head of the tibia; in fracture of the leg carry it to the middle of the thigh; in fracture of the lower end of the femur carry it to the pelvis.[1] Bradford warmly advocates the use of Thomas's splint often combined with plaster-of-Paris.

Prevention and Treatment of Complications.—In every case of fracture feel for the pulse below the injury in order to be sure the artery is not ruptured. If the soft parts are badly contused, try to prevent sloughing by employing rest, relaxation, and by applying heat. If superficial sloughing occurs, treat antiseptically, remembering that even a superficial excoriation can admit bacteria which, carried by the blood or lymph, may infect the bones. If a slough leads down to the fracture, treat the case as one of compound fracture. If there be great blood-extravasation, the danger is gangrene, and the foot of the bed is to be elevated, or the extremity, to which splints and bandages are to be loosely applied, is to be raised and surrounded with hot bottles. If a bleb forms, it is to be opened with a needle and dressed antiseptically. If gangrene occurs, treat by the usual rules. Frequently after fracture of a bone blebs containing reddish serum form on the skin. The appearance of blebs when the circulation is good does not mean gangrene, and is not of any particular consequence. If blebs are due to gangrene, there are distinct symptoms of circulatory impairment.

Edema may be due to tight bandaging. If it is due to phlebitis, there is danger of pulmonary or cerebral embolism. In phlebitis elevate the limb, remove all constriction, and employ locally tincture of iodin or ichthyol ointment; do not use massage, and give stimulants by the mouth.

[1] *Centralbl. f. Chir.*, vol. xxii., 1895.

In edema due to weak circulation or venous relaxation use daily frictions and firm bandaging. If the fracture involves a joint, carefully adjust the fragments, make passive motion

FIG. 111.—Fracture-hook (McBurney and Dowd).

early, and inform the patient that he will probably have a stiff joint.

A dislocation occurring with a fracture is reduced at once

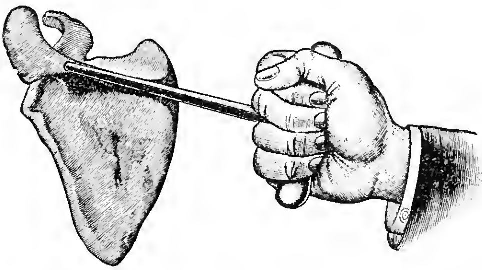


FIG. 112.—Fracture-hook applied at base of acromion process (McBurney and Dowd).

if possible. To do this, splint the limb and give ether, and try to reduce while the limb is managed with the splint as a handle. Allis is often able to reduce a dislocation accom-

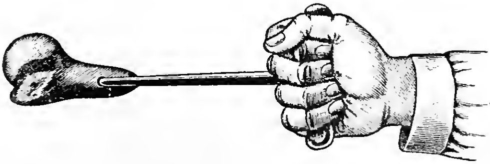


FIG. 113.—Fracture-hook inserted in displaced fragment (McBurney and Dowd).

panied by a fracture. He uses the untorn portion of periosteum as a hinge, pulls upon the fragment, and forces it in place by manipulation. If this fails, it is best to incise and

pull the separated end in place by the hook of McBurney and Dowd (Figs. 111–113); but some surgeons say, get the bones in the best possible position, set them, await union, and then treat the unreduced dislocation. A rupture of the main artery of the limb presents the symptoms of absent pulse below the rupture, a tumor which may pulsate, and possibly an aneurysmal thrill and bruit. This condition demands that the surgeon should apply an Esmarch bandage, cut down upon the tumor, turn out the clot, and ligate each end of the vessel. If these measures fail or if gangrene appears, amputate at once above the seat of the fracture.

Inflammation is to be treated by compression, rest, moderate cold, and later by a 50 per cent. ichthyol ointment. Muscular spasm requires morphin internally, firm bandaging, or even tenotomy. Fat-embolism is treated by stimulants and inhalation of oxygen, and possibly artificial respiration. Shock, delirium tremens, urinary retention, etc., are treated according to the ordinary rules of surgery.

Treatment of Compound Fractures.—It must first be decided, in a case of compound fracture of a limb, if amputation is necessary, and the *x*-rays are of great value in determining the condition of the bones in a crushed part. Amputation is demanded when the limb is completely crushed or pulpefied through its entire thickness; when extensive pieces of skin are torn off; when the main artery, vein, and nerve are torn through; and sometimes when there is violent hemorrhage from a deep-seated vessel; or when an important joint is badly splintered. What is to be done is to some extent determined by the patient's age and general health. In a healthy young person, if in doubt, give the limb the benefit of the doubt and try to save it; if the artery or vein alone is ruptured, cut down upon it and tie both ends; if the nerve is severed, suture it; if a joint is opened, drain and asepticize. If an attempt is made to save the limb, be ready at any time to amputate for gangrene, secondary hemorrhage (if re-ligation at original point and compression high up fail), extensive cellulitis, and profuse and prolonged suppuration.[1] When it is determined to try to save the limb, the part must be cleansed thoroughly by the antiseptic method (in no injuries is this more important). If a small portion of bone protrudes, cleanse the skin of the extremity and the protruding bone, push the spicule out a little more and cut it off. If a large piece of bone is protruded, it must

[1] See Howard Marsh on "Fractures," in Heath's *Dictionary of Practical Surgery*.

not be cut away, but should be thoroughly disinfected, and after the skin wound has been enlarged should be returned into place. Hemorrhage requires a free incision to permit of ligation of bleeding points. In comminuted fractures, fragments which are completely broken off should be removed, but those which are only partially separated should be retained. In all cases a drainage-tube must be carried down to the seat of fracture, and in some cases a counter-opening must be made and the tube be pulled through the limb (Fig. 114).

After inserting the tube the wound is sutured, a plentiful antiseptic dressing is applied, and the extremity is dressed

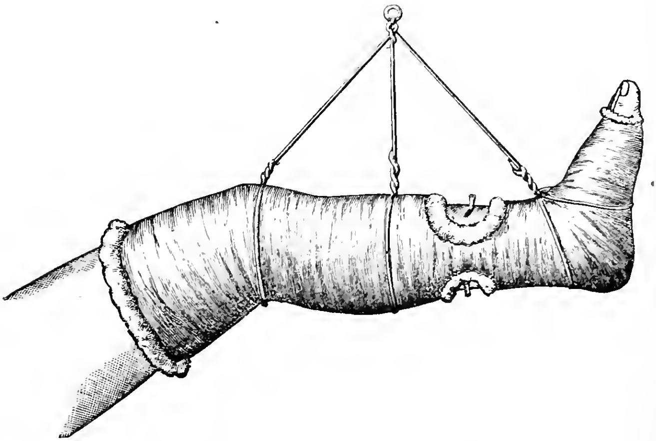


FIG. 114.—Fenestrated plaster-of-Paris dressing.

with plaster. The plaster can be applied over a narrow strip of wood, trap-doors being cut in the plaster before it sets (Fig. 114). A trap-door is cut over each end of the drainage-tube, and they are covered with gauze and a bandage.

The bracketed splint is a better dressing than the one just described. After the wound has been dressed with gauze, plaster is at once applied over the ends of brackets (Fig. 115). The above methods not only immobilize the fractured bones, but keep the parts aseptic and afford easy access to the wound. The drainage-tubes are usually removed, if suppuration does not occur, in from forty-eight to seventy-two hours. The wound is treated as any other wound. In some compound fractures there is difficulty in retaining the

fragments in apposition (lower end of femur, upper third of femur). In such cases the ends of the bone should be resected and the bones should be fastened together as in a case of united fracture, with silver wire, aluminum wire, chromicized catgut, or kangaroo-tendon. In a compound fracture of the patella after free incision and disinfection, investigate to determine the gravity of the injury. In an ordinary case in which there are two or three fragments, open the joint, irrigate with saline fluid, drill the fragments, and fasten them with silver wire. Very small fragments should be removed. A tube is carried into the joint, the wound is sutured and dressed, and the limb is immobilized. In cases of severe compound comminuted fracture of the patella, after disinfection, the loose

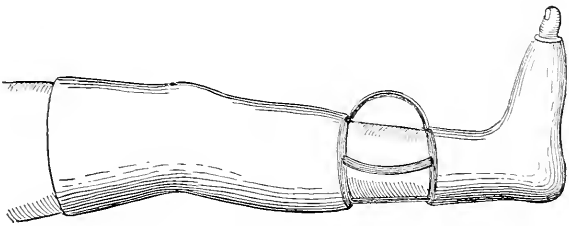


FIG. 115.—Bracketed plaster-of-Paris dressing.

piece should be removed and "the remaining portions made smooth with bone forceps and the sharp spoon."[1] The wound is only partially sutured, is drained and dressed, and the limb is placed on a splint. A compound fracture of the skull demands trephining. If a fracture of a rib is compound internally, resect the rib; if it is compound externally, dress antiseptically.

Compound fractures may be followed by gangrene, sloughing, periostitis, septicemia, pyemia, osteomyelitis, necrosis, etc. The treatment of these conditions is by well-known rules.

Treatment of Delayed Union and Ununited Fracture.—When delayed union exists, seek for a cause and remove it, treating constitutionally if required, and thoroughly immobilizing the parts by plaster. Orthopedic splints may be of value. Use of the limb while splinted, percussion over the fracture, and rubbing the fragments together, thus in each case producing irritation, have all been recommended. Blistering the skin with iodin or firing it has been employed. If the case be very long delayed, forcibly separate the frag-

[1] Lilienthal's *Imperative Surgery*.

ments and put up in plaster as a fresh break. If these means fail, irritate by subcutaneous drilling or scraping, or, better, by laying open the parts and then drilling and scraping at many places. Buechner advocates the induction of hyperemia by a constricting band, just as Bier induces congestive hyperemia in treating tubercular areas. At first the constriction is permitted to remain but a short time, but the period is lengthened every day, until in a few days it remains almost continuously day and night. He claims that ten days of almost continuous application cures most cases. Helferich devised this method in 1887. Lannelongue and Ménard inject a 1 : 10 solution of zinc chlorid between the fragments. Leaving acupuncture-needles in for days is approved by some, and electropuncture is advocated by others. Cases of ununited fracture must be treated by excision of the bony ends and fibrous tissue, securing the fragments together by periosteal sutures, by pins, by screws and plates, by ivory pegs, by screws, by silver or aluminum bronze wire, by kangaroo-tendon, by Senn's bone-ferrules, or by chromicized catgut. Delorme makes an incision, removes bone-splinters and fibrous tissue, smooths off one end, forces this into the bored-out medullary canal of the other fragment, and sutures the periosteum. Gussenbauer's clamp will often give a good result, and was used for years by Billroth. Parkhill's clamp (Fig. 116)

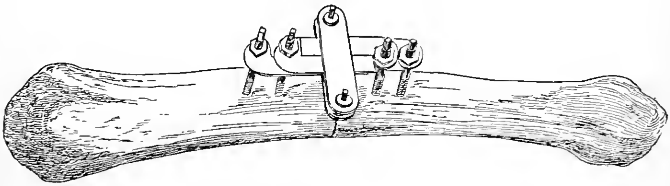


FIG. 116.—Parkhill's clamp for ununited fracture.

secures absolute immobility and is a very useful instrument (see Osteotomy for Ununited Fracture, p. 592).

Treatment of Vicious Union.—If angular deformity results from faulty union, it can be corrected by moulding while the callus is soft. If the callus has become hard, the bone can be refractured. If faulty union occurs with overriding, an osteotomy can be performed.

Special Fractures.—**Nasal Bones.**—The nasal bones, because of their situation, are often broken. The commonest site of fracture is through the lower third, where the bones are thin and lack support. The fracture may be compound

externally or internally. The *cause* is direct violence. Displacement may not occur at all, but when present it arises purely from force, and never from muscular action, no muscle being attached to these bones. If the force is from the front, the nose is flattened; if from the side, it is deflected. Displacement is soon masked by swelling. Crepitus can sometimes be elicited by grasping the upper part of the nose with the fingers of one hand and moving it below from side to side with the fingers of the other hand. Preternatural mobility is valueless as a sign, because of the natural mobility of the cartilages. Nose-breathing is difficult because of blocking of the nostrils by blood-clot. Diagnosis may be almost impossible when deformity is absent.

The complications that may be noted are cerebral concussion, brain-symptoms from implication of the frontal bone or cribriform plate of the ethmoid, and extension of fracture to the superior maxillary or lachrymal bones. Emphysema of the root of the nose, the eyelids, and the cheeks, is common, and means either a rent in the mucous membrane of Schneider or a crack in the frontal sinus. There may be much discoloration because of subcutaneous hemorrhage. Epistaxis is usual, and is recognized from the epistaxis produced by fracture of the base of the skull by the facts that the bleeding in the first condition is profuse, is, as a rule, soon checked, and is not followed by oozing of cerebrospinal fluid; whereas in the second condition it is profuse, continued, and followed by a flow of cerebrospinal fluid. Fracture of the bony septum occasionally complicates nasal fractures, and deviation of the cartilaginous septum often takes place. The prognosis is usually good.

Treatment.—When there is no displacement, or when a displacement does not tend to be reproduced after reduction, employ no retentive apparatus of any kind. Order the patient not to blow his nose for ten days and syringe it daily with a solution of bicarbonate of sodium. If deformity be noted, correct it at once, as the bones soon unite in deformity. If the attempts at reduction are very painful, or if the subject be a child, a woman, or a nervous man, give ether or spray the interior of the nose with a 4 per cent. solution of cocain. Reduction is effected by a grooved director or steel knitting-needle, wrapped in iodoform gauze and passed into the nostril; the fragments are lifted with this instrument, and the fingers externally mould them into place. A rubber dilator can be used in reduction. This is pushed into the nose and inflated by air or water. If hemorrhage

is moderate, check it with cold; if severe, by plugging. If flattening tends to recur, pass a Mason pin (Fig. 117) just beneath the fragments, through the line of fracture and out the opposite side. Steady the fragments by a piece of rubber externally caught on each end of the pin, or with figure-of-8 turns around the ends with silk. Leave the pin in place for five days. The instrument of Mason is a sharp, strong, nickel-plated pin, with a triangular point.

FIG. 117.—Mason's pin.

If a lateral deformity tends to recur, hold a compress over the fracture or fix a moulded-rubber splint over the nose by a piece of rubber plaster one and a half inches broad and long enough to reach well across the face, and use compression for ten days. In neither of the above cases is the nose to be blown, and in both cases it is to be syringed daily. In fractures rendered compound by tears in the mucous membrane irrigate with normal salt solution or boracic-acid solution, holding the head so that the solution will not run into the mouth; plug with iodoform gauze around a small rubber catheter, which instrument permits nose-breathing; carefully remove the gauze daily and syringe. In fractures compound externally cleanse antiseptically externally, and dress with a film of cotton soaked in iodoform collodion or compound tincture of benzoin, or apply sterile gauze. Fractures of the bony septum, if showing a tendency to reproduction of deformity, require packing as above explained, or the use of a special splint within the nostrils (Fig. 118). Fractures of the nasal cartilages are to be pinned in place. Fractures of the nose are entirely united in from ten to twelve days.

FIG. 118.—Jones's nasal splint.

Fractures of the Lachrymal Bone.—The lachrymal bone may be broken when the nasal bones, a superio maxillary bone, or the lateral plate of the ethmoid are fractured.

Treatment.—Treat the chief injury, which is the fracture of the other bone. Maintain the patency of the lachrymal duct by passing frequently a clean probe.

Fractures of the Superior Maxillary Bone.—Although a fragile bone, the superior maxillary is rarely broken except through the alveolar border. It may be broken by transmitted force from blows on the chin, or on the head when the chin is fixed; but direct violence is the usual cause, and the wall of the antrum may be crushed in. Comminution is the rule, and the injury is often compound. These fractures induce great swelling, pain, and inability to chew. Mobility and crepitus may be detected. Deformity is due to the breaking force, and not to the action of any muscle. When a portion of the alveolar arch is fractured, as may occur in pulling teeth, the fragment is depressed backward, and there exist irregularity of the teeth (some of which may be loosened) and inability to chew food. Fracture of the nasal process is apt to injure the lachrymal duct. When the antrum is broken in there are great sinking over the fracture, depression of the malar bone, and emphysema. Transverse fracture of the upper part of the body of the bone may cause no deformity. The force sufficient to break the superior maxillary bone is so great that fractures of other bones almost certainly occur, and concussion of the brain not infrequently exists. Injury of the infraorbital nerve is not unusual, causing pain, numbness, or an area of anesthesia involving one-half of the upper lip, the ala of the nose, and a triangle whose base is one-half the upper lip and whose apex is the infraorbital foramen. There is also loss of sensation in the gums and upper teeth of the injured side. Fractures of the superior maxillary bone occasionally induce fierce hemorrhage from branches of the internal maxillary artery; and if this occurs, watch out for secondary hemorrhage (these vessels being in firm canals).

Treatment.—If the fracture does not implicate the alveolus, or if no deformity exists, apply no apparatus, but feed the patient on liquid food for four weeks. Reduce deformity, if it exists, by inserting a finger in the mouth. If the antrum is broken in, put the thumb in the mouth and push the malar bone up and back. In certain cases of deformity make an incision at the anterior border of the masseter muscle, insert a tenaculum or aneurysm-needle, and pull the bone into place (Hamilton). If the malar bone or malar process is driven into the antrum, Weir tells us to incise the mucous membrane above and external to the canine tooth of the upper jaw, break into the antrum with a bone-gouge, insert a steel sound, lift out the malar bone, and pack the antrum with gauze. Loose teeth are not to be removed; they are pushed

back into place and held by wiring them to their firmer neighbors. Hemorrhage is arrested by cold and pressure. If hemorrhage is dangerously profuse or prolonged, tie the external carotid.

If the line of the teeth, notwithstanding the wiring, is not regular, mould on an interdental splint. The usual splint for the upper jaw is the lower jaw held firmly against it by the Gibson, the Barton, or the four-tailed bandage. Every second day remove the bandage and wash the face with ethereal soap. The patient, who is ordered not to talk, is to live on liquid food administered by pouring it into the mouth back of the last molar tooth by means of a tube or a feeding-cup. Never pull a tooth to get a space; but if a tooth is lost, utilize its space for this purpose. After every meal wash out the mouth with peroxid of hydrogen, followed by chlorate-of-potassium, boracic-acid, or normal salt solution, and thus prevent foulness and the digestive disorders it may induce. Leave off the dressings in five weeks, and let the patient gradually return to ordinary diet.

In fractures compound externally do not remove fragments, antisepticize, arrest bleeding as far as possible by ligature, by pressure, or by plugging, wire the fragments if feasible, dress with gauze, and wash the mouth with great frequency. Fractures compound internally are treated as simple fractures, except that the mouth is washed more frequently.

The **malar bone** is rarely broken alone. Hamilton says no uncomplicated case is on record. The malar is a strong bone resting on a fragile support, and hence it may become a wedge to break other bones and yet itself be unfractured. The *cause* of fracture is violent direct force. A fracture of the orbital surface of this bone causes subconjunctival hemorrhage like that encountered in fracture at the base of the skull. Protrusion of the eye may result either from hemorrhage or from crushing in of the malar bone. Chewing is apt to cause pain.

Treatment.—If no deformity exists, there is practically nothing to be done. If deformity exists, try to correct it as in fractures of the superior maxillary bone. As these cases are almost invariably complicated by fracture of the upper jaw, they are treated in the same manner as the latter injury. The union is complete in three weeks.

Fractures of the zygomatic arch are very rare. The *causes* are (1) direct violence; (2) indirect force (from depression of the malar); and (3) forcing of foreign bodies through the

mouth. Direct violence is the usual cause. Direct violence causes inward displacement, and indirect force may cause outward displacement. The usual seat of fracture is at the smallest portion of the process—that is, on the temporal side of the temporomalar suture (Matas). The symptoms are pain, ecchymosis, swelling, displacement, and difficulty in moving the jaw (because of injury to the masseter muscle).

Treatment.—In simple fracture give ether and try to push the arch in place. Many surgeons do not make an incision, as depression will do no harm and the functions of the jaw will be restored. Simply dress with a compress, adhesive strips, and the crossed bandage of the angle of the jaw. Union will take place in three weeks. Matas[1] advises operation. An anesthetic is administered, and the parts are asepticized. A long semicircular Hagedorn needle is threaded with silk, is entered one inch above the middle of the displaced fragment, is passed well into the temporal fossa, and is made to emerge half an inch below the arch. The silk is used to pull a silver wire through around the fracture, and this wire is employed to pull the bone into position. A firm pad is applied externally and the wire is twisted over the pad. Antiseptic dressings are applied, and on the ninth or tenth day the wire, splint, and dressings are removed permanently. I have employed this plan in one case with perfect satisfaction.

Fractures of the inferior maxillary bone may, and most usually do, affect the body, although they occasionally occur in the rami. Any part of the body may be fractured, the most usual seat being near the canine tooth or a little external to the symphysis (Pick). A portion of alveolus may be broken off. In fractures of the ramus either the angle, the condyloid neck, or the coronoid process may be broken. In fractures of the body the posterior fragment generally overrides the anterior. Fractures of the lower jaw are often multiple and are almost always compound, because the oral mucous membrane and alveolar periosteum are torn. The *cause* is usually direct violence. Indirect violence (lateral pressure) may fracture the body anteriorly. Fractures near the angle are always due to direct violence. Indirect violence may fracture the condyle (falls on the chin), and so may direct violence. Fractures of the coronoid process are very rare, and they arise from great direct violence (usually a gunshot-wound or some other penetrating force).

Symptoms.—In fracture of the body preternatural mobility and crepitus generally exist. There is bleeding because of

[1] *New Orleans Med. and Surg. Jour.*, September, 1896.

laceration of the gums; saliva dribbles constantly; the patient supports the jaw with the hand; great pain exists (possibly from injury of the nerve); and deformity is present, shown by inequality of the teeth if the fracture is anterior to the masseter, the anterior fragment going downward and backward and the posterior fragment going upward and forward. The downward displacement is due to muscular action (action of the digastric, geniohyoid, and geniohyoglossus). The backward displacement is due to the violence. The temporal muscle draws the posterior fragment upward and to the front. In fracture of the neck of the condyle the jaw is drawn toward the injured side, and the condyle is pulled inward and forward by the action of the external pterygoid muscle. In fracture of the coronoid process the temporal muscle pulls the small fragment upward.

Complications.—The complications are—digestive disorders and diarrhea from swallowing foul discharges; loosening of the teeth; lodgement of loosened teeth between the fragments; bleeding (usually only oozing from the gums, but there may be hemorrhage from the inferior dental artery); and suppuration. Necrosis may follow these fractures.

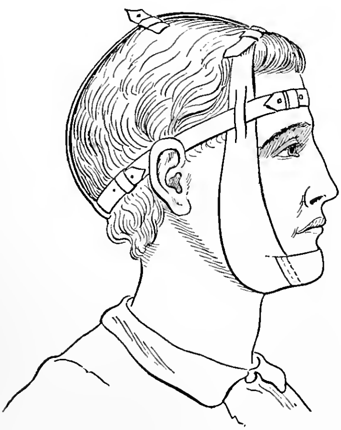


Fig. 119.—Hamilton's bandage.

Treatment. — Remove a tooth if it lies between the fragments, but replace it in its socket after reducing the fracture. Correct deformity. Push loose teeth into place and put back detached ones. Wash the mouth with hot water to clean it and to check bleeding. If bleeding is very severe, compress the carotid artery for a time. The fracture can be dressed with a pad of lint over the chin and Hamilton's four-tailed bandage (Fig. 119). A common plan is to take a splint of pasteboard, felt, or gutta-percha; pad it lightly with cotton, mould it to the part, and hold it in place with a Barton or a Gibson bandage. If apposition of the fragments cannot be maintained by the above methods, fasten the teeth together with wire, wire the fragments together, or have a dentist apply an interdental splint (Figs. 120, 121). Fracture

of the lower jaw can often be most satisfactorily treated by the Angle's bands. These bands are of great value in complicated cases, in which two or more fractures exist. Each band consists of thin metal and a screw and a nut to fit the screw. The band is adjusted around a firm tooth and the nut is applied so as to hold the band tightly. Several bands are

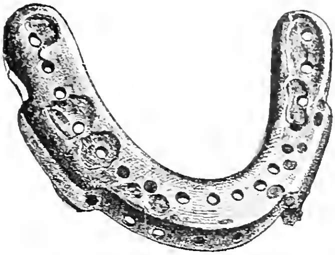


FIG. 120.—Vulcanite splint with boxes vulcanized on each side. If the jaw is fractured in the region of the molars, considerable pressure is required to get the parts in position; therefore it is best to vulcanize on to the sides of the vulcanite splint boxes into which wire arms can be inserted (Pilcher).

placed upon teeth in both jaws. Silver wire or silk is thrown around the pins of the bands so as to catch, and the jaws are thus held firmly together. I have had these bands applied for me in fracture of the jaw with excellent result by Dr. C. P. Chopein. The patient is to be fed on liquid food (see

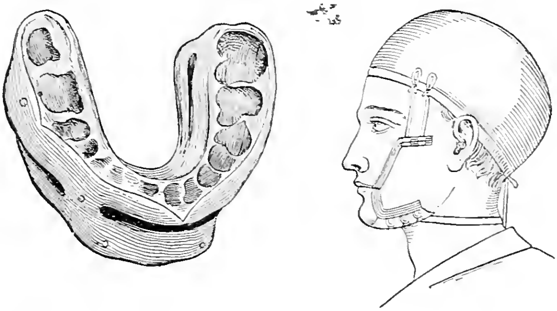


FIG. 121.—Interdental splints.

Fracture of the Upper Jaw, p. 430), the mouth is to be washed frequently with peroxid of hydrogen, followed by boric-acid solution or normal salt solution, and the dressings are to be changed every second day. The union should be complete in five weeks. Though these fractures are usually compound, they do not endanger life.

Fractures of the Hyoid Bone.—These fractures are rare

injuries, and are caused by hanging, by the throat being grasped by an antagonist, and by falls in which the neck strikes some obstacle. If the bone breaks by throttling, it is its body which fractures (indirect force). Fractures by muscular action are most unusual.

Symptoms.—The symptoms are—a sensation of something breaking; bleeding from the mouth if the mucous membrane be lacerated; pain, which is worse on opening the jaws or on moving the head or tongue; difficulty in swallowing; muffled, hoarse, or absent voice; swelling, and frequently ecchymosis, of the neck. There are observed occasionally, though rarely, harsh cough and dyspnea, irregularity of bony contour, and crepitus. Always look into the mouth and see if there can be detected ecchymosis or laceration of the mucous membrane or projection of a bony fragment. The displacement is due to the middle constrictor of the pharynx contracting. A fracture of the hyoid bone may destroy life.

Treatment.—For dyspnea, be ready to perform intubation or tracheotomy at a moment's notice. Edema of the glottis is a great danger. Try to restore the fragments with one hand externally and with a finger in the mouth. Put the patient to bed and have him lie back upon a firm rest so that his shoulders are elevated. His head is to be placed between extension and flexion, a pasteboard splint or collar is moulded on the neck, and a bandage is applied around the forehead, neck, and shoulders to keep the head immobile. The patient must not utter a word for a week; he must at first be fed by enemata, and then for some time on liquid diet, which is given through a tube early in the case. Endeavor to control the cough by opiates. A fractured hyoid bone requires about four weeks to unite.

Fracture of laryngeal cartilages is caused by direct violence, as throttling, blows, or kicks. It is rare in young persons, and is commonest when the cartilages have begun to ossify. It is a very grave injury, death arising from obstruction to the entrance of air.

Symptoms.—The symptoms, which are severe, are pain, aggravated by attempts at swallowing or speaking; swelling, ecchymosis it may be, and emphysema of the neck; cough; aphonia; intense dyspnea; and bloody expectoration if the mucous membrane is ruptured. There can be detected inequality of outline (flattening or projection) and perhaps moist crepitus. The usual seat of the injury is the thyroid cartilage.

Treatment.—Cases without dyspnea require quiet, avoidance of all talking, feeding with a stomach-tube, the application of compresses and adhesive strips over the fracture, and the use of remedies to quiet cough. The surgeon must be ready to operate at any moment. In most cases dyspnea exists, due to projection of the fragments or submucous extravasation. When there is dyspnea, emphysema, or spitting of blood, at once practise intubation, or, if unable to do this, open the larynx or trachea below the seat of fracture. If laryngotomy or tracheotomy is performed, try to restore to proper position displaced fragments. If the fragments will not remain reduced, introduce a Trendelenburg cannula or a tracheotomy-tube, around which gauze is packed. Take out the packing in four days, and remove the tube as soon as the patient breathes well, when the opening may be allowed to close. In these fractures feed with a stomach-tube and keep the patient absolutely quiet. Union takes place in four weeks.

Fractures of the Ribs.—The ribs, owing to their shape, elasticity, and mode of attachment, readily bend and as readily recover their shape, and thus withstand considerable force without breaking. Notwithstanding these facts, the situation of the ribs so exposes them that in 16 per cent. of all cases of fractures noted by Gurlt these bones were involved. In children this injury is rare and is most usually incomplete; it is common in adults and the aged, and in them is generally complete. It is more frequent among men than among women. The ribs commonly broken are from the fifth to the ninth, the seventh being the one that usually suffers. Fracture of the first rib alone is an excessively rare accident. The eleventh and twelfth ribs are seldom broken. A rib may be broken in several places, and several ribs are often broken at the same time. Fracture of a single rib is not nearly so common as fracture of several ribs. These fractures may be compound either through the skin or through the pleura, a damaged lung permitting pneumothorax. Compound fractures are very rare, however, except from bullet-wounds.

Causes.—*Direct* force, as buffer accidents, kicks, blows with heavy instruments, or being jumped on while recumbent, may produce these injuries. A fracture from direct violence occurs at the point struck, and the ends, projecting inward, may damage a viscus. *Indirect* force, as great pressure or blows which exaggerate the natural bony curves, tends to produce fractures near the middle of the ribs or in front of

their angles and to force the ends outward. A number of ribs are apt to be broken. Muscular action, as in coughing or parturition, occasionally, but very rarely, is a cause.

Symptoms.—In connection with the history of the accident the symptoms are—acute localized pain (a stitch) on breathing, increased by pressure over the injury, pressure backward over the sternum, cough, and forcible inspiration or expiration; respiration is largely diaphragmatic, the patient endeavoring to immobilize the injured side; cough is frequent and is suppressed because of pain. Crepitus is often but not invariably found. It is sought, first, by resting the palm over the seat of pain while the patient takes long breaths; second, by placing a thumb before and one behind the seat of pain and making alternate pressure; and third, by auscultation. It should be remembered that incomplete fractures are the rule in children; hence in them do not expect crepitus. Deformity is usually trivial unless several ribs are broken, because shortening cannot occur and the intercostal attachments prevent vertical displacement. Preternatural mobility may occasionally be elicited, when the region is not deeply covered with muscles, by pressing on one side of the supposed break and observing that a part of, and not the entire, rib moves. If air gathers in the subcutaneous tissue and there is no wound of the surface, it is proof of rib fracture with lung-damage. In such a case the lung has been penetrated by a fragment, and air has been forced out into the tissues. This condition is recognized by great and growing swelling, which crackles when touched. Such a collection of air is known as cellular emphysema. Bloody expectoration suggests lung injury; bloody expectoration and cellular emphysema, without an external wound, prove injury of the lung. A simple, uncomplicated case in a young person gives a good prognosis.

The *complications* are—additional injury, making the fracture externally or internally compound; laceration of the pleura, pericardium, heart, lung, diaphragm, liver, spleen, or colon; rupture of an intercostal artery; hemothorax; cellular emphysema; pulmonary emphysema; pneumothorax and pyothorax; traumatic pleurisy; pneumonia; bronchitis; congestion or edema of the lungs.

Treatment.—In an uncomplicated case the patient is not kept in bed, as breathing is easier when erect than when recumbent. Angular displacement outward is corrected by direct pressure. Displacement inward is soon corrected, as a rule, by the expansion of ordinary respiratory action; but

if it is not thus corrected, etherize, the deep breathing of the anesthetic state almost always succeeding. If ether fails and dangerous symptoms come on, incise under strict antiseptic precautions, elevate, and drain, or sometimes resect the rib.

After correcting any existing deformity immobilize the injured side. Direct the patient to raise his arms above his head, to empty his chest-air by a forced expiration, and to keep it empty until a piece of rubber plaster (two inches wide) is forcibly applied seven or eight inches below the fracture and from the spine to the sternum. The patient is now allowed to take a breath and is directed to empty the chest again, another piece of plaster being applied, covering the upper two-thirds of the width of the first strip. This process is continued until the side is strapped well above and well below the fracture (Pl. 6, Fig. 13). Over the plaster light turns of a spiral bandage of muslin are carried, or a figure-of-8 bandage of the chest is applied, the turns crossing over the seat of injury. About once a week the plaster is removed and fresh pieces applied after rubbing the chest with soap liniment, drying, and anointing excoriations with an ointment of oxid of zinc. The dressing is worn for three or four weeks. The patient avoids cold, damp, and draughts. The diet must be nutritious but non-stimulating, and any cough should be treated by opiates and expectorants. A person with this injury who has reached the age of sixty must take stimulant expectorants (ammonii carb., gr. x, in infus. senegæ, ℥ss, t. i. d.) or employ a steam-tent several times a day. The old method of treatment, in which the chest was included in a forcibly applied broad rib-roller, is not to be used except as a temporary expedient; it compresses the entire chest, causes pain and dyspnea, and tends to loosen and slip.

Fracture of the ribs complicated with visceral injury is highly dangerous, and requires confinement to bed. The treatment is that of the visceral injury. If there be bloody expectoration, apply adhesive strips as above indicated, put the patient to bed reclining on a bed-rest, keep him quiet, subdue the circulation, and employ opium, diaphoretics, and expectorants (a good mixture consists of squill, ipecac, ammonium acetate, and chloroform; opium is given separately). Inflammations of the lung or the pleura, fortunately, are apt to be localized, and are treated as are ordinary inflammations of these parts. If signs of pulmonary injury are severe from the start or become worse under medical treatment, incise, resect a rib, arrest hemorrhage, and drain the pleura. In lacera-

tion of an intercostal artery incise and try to ligate; if unable to ligate, resect a rib and apply a ligature. If the signs point to internal bleeding, resect a rib, search for the bleeding point, and ligate. Emphysema usually soon disappears; but if it does not, make many small incisions in the cellular tissue, dress antiseptically, and employ pressure. When there arises a sudden attack of dyspnea, which is prone to happen in these cases, and in which the face becomes blue, the heart labors, and suffocation seems imminent, bleed the patient almost to syncope.

Fractures of the costal cartilages are not common, even in the aged. Such fractures occur either through the cartilages or through their points of junction with the ribs. These injuries generally arise from direct violence, the cartilage of the eighth rib being most prone to suffer. Indirect force (such as a blow upon the shoulder) is occasionally the cause, but when it is the cause some other injury besides the fracture of the cartilages is apt to be noticed. Muscular action is a possible cause.

Symptoms.—Displacement is often absent; but if present, it is forward or backward of either fragment, and is due chiefly to the force of the injury, but partly, it may be, to muscular action. When displacement is absent crepitus will not often be found; in fact, crepitus is usually absent in these injuries. Localized pain, swelling, and ecchymosis are noted. Preternatural mobility may or may not be detected. Union by bone is to be expected.

Treatment.—If displacement exists, try to reduce it. If the fragment is displaced backward, reduce by deep inspirations; if the fragment is displaced forward, reduce by pulling back the shoulders. In this attempt failure is the rule, and the surgeon may then adopt Malgaigne's expedient of applying a truss over the projection for a day or two. Dress and treat the case as if a rib were broken, removing the dressings in four weeks. See 7 10

Fractures of the Sternum.—The sternum may be broken, along with the ribs and spine, from great violence. Fractures of the sternum alone are infrequent, because the bone rests on a spring-bed of ribs. Fractures of the sternum may be simple or compound, complete or incomplete, single or multiple. The most usual injury is a simple transverse fracture at or near the gladiomanubrial junction, at which point dislocation may also occur. Both fracture and separation of the ensiform cartilage are very rare. The sternum may be broken along with the ribs or clavicle.

Causes.—The causes of fracture of the sternum are—*direct* force, as by a fall of an embankment or of a wall, by a car-crush, or by the passing of a cart-wheel over the body; *indirect* force, as by a fall upon the head, thus driving the chin against the chest; by a fall upon the feet, the buttocks, or the shoulder; by forced flexion or extension of the body over an edge or angle (as may occur during labor-pains).

Symptoms.—In fracture of the sternum displacement is not always present, but when it does occur the lower fragment is apt to pass forward; displacement may, however, be transverse or angular, or there may be overriding. The posterior periosteum, which rarely tears, limits displacement, but some deformity can, as a rule, be detected. The history of the nature of the accident has a valuable bearing upon the question of diagnosis. The position assumed by the patient is with the head and body bent forward, as attempts to straighten up cause much suffering. There is fixed and localized pain, increased by deep respiratory action, by body-movements, or by cough. Crepitus is sought for by auscultation and by placing the hand over the injury and directing the patient to make quick respirations. Mobility may become manifest on external pressure, during respiration, or while attempts are being made to bring the body erect. Respiration in these cases is usually much interfered with. It is not important to separate diastasis from fracture.

Complications.—Other fractures generally complicate fracture of the sternum, and laceration of the pleura or pericardium and hemorrhage into the anterior mediastinum may exist. Abscess of the mediastinum and necrosis of the sternum may appear as late consequences. The *prognosis* is good in uncomplicated cases.

Treatment.—The deformity attending fracture of the sternum is to be corrected, if possible, by external pressure. If overriding is found, effect reduction by bending the body back over a firm pillow and ordering the patient to respire deeply; if this method fails, give ether and then bend the body backward. The deformity, after reduction, tends to recur, but the bones unite well even in deformity, and no great harm results. The fragments need not be cut down on or be hooked up unless there be internal injury. After reducing the deformity, cover the front of the chest with adhesive strips extending laterally from one axillary line to the other, and covering a region from above the fracture down to the ensiform cartilage. Place over this covering an anterior figure-of-8 bandage of the chest. In some cases, where deformity recurs

after reduction, a circular bandage of the chest is applied and the shoulders are pulled strongly back with a posterior figure-of-8 bandage. The plaster is to be reapplied once a week. Some surgeons treat these cases by means of a large compress held by adhesive plaster and a broad tight roller.

The patient must be promptly put to bed, and reposes erect or semi-erect on a bed-rest. This position favors easy respiration and antagonizes the tendency to displacement. The diet should be light, nutritious, and non-stimulating. The patient becomes convalescent in four weeks, and the plaster should be permanently removed in five weeks. When the ensiform cartilage is so bent in as to cause intense pain or to injure the stomach, it should be exposed by incision and resected. Edema of the skin and fever, if they appear, indicate pus, in which case an incision should be made at the edge of the sternum and the pus-cavity should be irrigated and drained.

Fractures of the Pelvis.—In some of the indicated fractures serious injury of the pelvic contents is apt to be found.

Fractures of the False Pelvis.—Fractures of this region are seldom dangerous unless comminuted. There may be fracture of the iliac crest or of the anterior superior spine, or the line of fracture may traverse the entire length of the flanged-out ilium, or the bone may be comminuted with the association of grave visceral damage. The anterior superior and posterior superior spines may be broken off.

Causes.—The cause of fracture of the false pelvis is generally violent *direct* force, as the passage of a wagon-wheel, the fall of a wall, the kick of a horse or mule, or the force of car-crushes. Violent contraction of the rectus muscle may tear off the anterior inferior spine of the ilium.

Symptoms.—In fracture of the false pelvis the history of violent force is noted. The patient leans toward the injured side. Pain exists, which is aggravated by movements (particularly by bending forward), by coughing, or by straining to empty the bowels or the bladder. Ecchymosis and swelling are manifest. Crepitus and preternatural mobility are detected by moving the iliac crest. Deformity is very rarely present. Cases uncomplicated by visceral injury make good recoveries.

Complications.—The fracture may be, but rarely is, compound, as the parts are well protected with muscles. The colon may be injured when comminution has taken place.

Treatment.—In treating fracture of the false pelvis put the

patient on a fracture-bed, raise the shoulders, and apply a binder about the pelvis, or encase the pelvis with broad pieces of rubber plaster, or employ the belt or girdle. Place the knees over two pillows so as to semiflex the legs and thighs, and tie the knees together. To restrain thigh-movements it may be necessary to encase a restless patient with splints or bind him to sand-bags. If the binder displaces the fragments or causes pain, abandon it and trust to position. The dressings can be removed in six weeks, and the patient is allowed to get up in eight weeks. In compound fractures of the false pelvis asepticize, drain and dress, put on a binder, and direct the same position to be maintained as for simple fractures.

Fractures of the True Pelvis.—The most usual seat of these fractures is through the obturator foramen, the ascending ischial and horizontal pubic rami being broken. A fracture may occur near the symphysis pubis, the symphysis may be separated, a break may run near to or into the sacro-iliac joint, the same fracture may occur on each side of the body of the pubis, and there may be multiple fractures. Fractures of the acetabulum and of the tuberosity of the ischium may occur. Before the seventeenth year the innominate bone may be broken into its three anatomical segments. These injuries are highly dangerous because of the damage which is apt to be inflicted on the pelvic contents. There may be rupture of the bladder or membranous urethra and injury of the vagina, the rectum, the uterus, or the small gut. The *cause* of pelvic fracture is violent force, direct or indirect. Front force tends to produce direct, and side force indirect fracture. The acetabulum may be broken by falls upon the feet.

Symptoms.—In pelvic fracture there is a history of violent force. There are great shock, ecchymosis which is possibly linear, swelling, and intense pain increased by attempts at motion, coughing, and straining. There is also inability to sit or to stand. Mobility becomes obvious on grasping an ilium in each hand and moving the hands. Crepitus may be noticed by this maneuver or by moving an ilium with one hand, a finger of the other hand being inserted in the rectum or vagina. In making movements for diagnostic purposes be very gentle, as rough manipulation may cause injury by sharp fragments. There may be doubt as to whether crepitus is to be referred to pelvic fracture or to fracture of the neck of the femur; in this case follow the rule of John Wood: "The surgeon grasps the femur with one hand and places the other firmly upon the anterior supe-

rior iliac spine or crest or upon the pubes; then, on moving the femur and abducting it freely, if a crepitus be detected, it will be felt the more distinctly by that hand which rests on or grasps the fractured bone."

Injury of the bladder or urethra is made manifest by retention of urine, extravasation of urine, hematuria, etc. In some cases the urine is extravasated into the prevesical space. Bleeding from the vagina or the rectum points to a laceration of the part by a fragment. The vagina may be badly lacerated and the bowels may emerge from the laceration (Morris Richardson's case). Intestinal injury is apt to induce septic peritonitis. Fracture of the brim of the acetabulum permits dorsal dislocation of the femur to occur, which dislocation will not remain reduced. Fracture of the brim of the acetabulum causes shortening, which at once recurs when extension is abandoned—inversion and adduction, although the power of eversion and abduction is preserved (Stokes). There is crepitus, and the head of the bone goes with the fragment upward and backward (Stokes). If the head of the femur be driven through the acetabulum into the pelvis, the injury is very grave; there are then found shortening, adduction, and semiflexion of the thigh, absence of the prominence of the great trochanter, and more capacity for movement than is noted in dislocation. Fracture of the ischium rarely occurs alone.

Treatment.—Examine carefully to see if the bowel, the bladder, or the vagina is injured. If such an injury exists, radical operation is of course demanded. Always use a catheter to see if the urine is bloody. In treating a pelvic fracture endeavor to restore the parts to a normal position, employing external manipulation and inserting a finger in the rectum or in the vagina. If reduction is difficult, give ether. Treat as in fracture of the false pelvis, attending carefully to visceral injuries. In fracture with separation of the pubic bones, the bones should be wired together. If urinary extravasation occurs, perform perineal section. If there are signs of bowel injury, perform laparotomy. All visceral injuries are treated by general rules. Remove the dressings in six weeks and allow the patient to be about in twelve weeks. In fracture of the acetabulum, if the limb be shortened, give ether and reduce. Treat these fractures in the same way as intracapsular fractures of the femur (p. 478). Fractures of the ischium are best treated by the application of a pad and adhesive plaster, and rest in bed.

Fractures of the Sacrum.—This bone may be broken by

direct force, such as a kick, but the injury is rare. The sacral plexus is usually injured, and if it is paralysis is observed in the territory of its branches.

Symptoms.—The symptoms in fracture of the sacrum are pain, frequently incontinence of feces and retention of urine, irregularity of the sacral spines, ecchymosis, and crepitus. Crepitus may be sought for with one hand externally and a finger of the other hand in the rectum. The lower fragment passes forward and may obstruct or may tear the rectum. Paralysis may be found in the area of distribution of the sacral plexus.

Treatment.—In treating fracture of the sacrum press the fragments into place with a hand externally and a finger in the rectum. Do not plug the rectum. Put a pad over the upper fragment, hold it with plaster or a binder, place the patient recumbent on a fracture-bed, and insert a large cushion underneath the pad. Some surgeons give opium to induce constipation, and allow a fecal support to accumulate in the rectum. Use a clean catheter regularly, and guard against bed-sores. Union occurs in about four weeks, when the dressing can be removed. The patient can get about again in six weeks. If urinary retention persists or if intractable bed-sores form after eight or ten weeks, cut down on the seat of injury and elevate or remove the portion of bone causing pressure.

Fractures of the Coccyx.—The coccyx may be broken or be separated from the sacrum by a fall, a blow, a kick, or the straining of parturition. Its mobility is so great, however, that it does not often break.

Symptoms.—The chief symptom of fracture of the coccyx is pain, which is much aggravated by sitting, walking, or straining at stool. If the index finger is inserted in the rectum, the displaced bone is felt; if the thumb of the same hand is also placed externally, a rocking motion will develop crepitus and preternatural mobility.

Treatment.—In treating fracture of the coccyx reduce by external pressure and by the manipulations of a finger in the rectum. Put the patient to bed and obstruct the bowels by opium for a number of days. In four weeks the fracture should be united. If union does not take place, defecation and all movements of the coccyx will cause excruciating pain by pressure on the last sacral nerve. This condition, known as "coccygodynia," demands a subcutaneous division of the nerve or of the muscles which move the coccyx, or a resection of the bone.

Fractures of the Vertebra. (See p. 710).

Fractures of the Skull. (See p. 664).

Fractures of the Clavicle.—The clavicle is more often fractured than any other bone. The fracture may occur at any age, but is commonest before the sixth year (Hulke says one-half of the recorded cases). It may be simple, multiple, comminuted, oblique, transverse, complete, incomplete, or, very rarely, compound. Both clavicles may be broken. Fractures are most apt to occur just external to the middle, at the point where the inner or large curve meets the outer or small curve, at which junction the bone is at its smallest diameter. Fractures of the acromial end are more frequent than fractures of the sternal end, and less frequent than fractures of the shaft. The *causes* of fracture of the clavicle are direct violence, indirect violence, and, very rarely, the contractions of "the deltoid and clavicular fibers of the great pectoral" (Treves, from Polaillon).

Fractures of the shaft are usually due to indirect violence, as falls upon the shoulder or upon the outstretched hand. In the latter accident, which is the usual mode of origin, the concussion of the fall travels up and the body-weight travels down, and these two forces compress the bone, which snaps at its weakest point. Fractures from indirect force are oblique, and in children are of the green-stick form. Fractures from direct force are usually transverse, and are occasionally comminuted. Fractures from muscular action have been recorded (Rubini the tenor, recorded by Melay).

Symptoms.—In fracture of the shaft of the clavicle the attitude of the patient is peculiar. He supports the elbow or wrist of the injured side with the hand of the sound side, and also pulls the extremity against the chest; the head is turned down toward the shoulder of the damaged side, as if trying to listen to something in the joint, thus relaxing the pull of the sternocleidomastoid muscle upon the inner fragment. The shoulder is nearer the sternum, on a lower level, and farther front than that of the sound side. Loss of function is shown by inability to abduct the arm. Considerable pain exists, which is increased by motion, by pressure, and by hanging down the extremity without support.

The deformity above noted is described by stating that the shoulder goes downward, inward, and forward (D. I. F.). The *downward* deformity is chiefly due to the weight of the arm, which pulls down the unsupported outer fragment, and is contributed to by the action of the pectoralis minor muscle. The *inward* deformity is chiefly due to the con-

traction of the pectoralis minor and subclavius muscles assisted by the action of the pectoralis major. The *forward* deformity is due to rotation of the outer fragment, which is brought about by the serratus magnus muscle carrying the scapula forward. In this deformity, the inner end of the outer fragment is below and behind the outer end of the inner fragment, which overrides it. The inner fragment, though pulled on by the sternomastoid and relatively higher than the outer fragment, is really but little, if at all, elevated, marked elevation being prevented by the attachment of the rhomboid ligament. After noting the deformity, detect with the finger the irregularity of bony contour. Examine for preternatural mobility and crepitus by raising and throwing back the shoulder. In looking for these signs in children it is to be remembered that the fracture is probably incomplete. The prognosis is good, the bone uniting, but always with some shortening and inequality.

Complications.—Fractures of the shaft are rarely compound, because the sharp end of the outer fragment passes backward and because of the free play the skin makes over the bone (Pickering Pick). Both clavicles may be broken. In fractures from direct force deeper structures may be injured by fragments. Thus, injury of the brachial plexus will induce paralysis. Injury of the vein or artery may occur. Ribs may be broken at the same time.

Treatment.—In treating a fracture of the shaft correct the deformity as soon as possible by throwing the shoulder upward, outward, and backward. If the patient is a girl, it is desirable to minimize the deformity. Place her upon her back on a hard bed, with a small pillow under her head, a firm and narrow cushion between the shoulders, a bag of shot resting over the seat of fracture, and the forearm lying on the front of the chest, the arm being held to the side by a sand-bag. In three weeks there will be union, practically without deformity. In a child with an incomplete fracture a handkerchief sling for the forearm, worn three weeks, is all that is needed. In complete fracture the Velpeau bandage is efficient. Before applying it, place lint around the chest and cotton over the elbow. Change the bandage every day for the first week, and after that period every third day. Each time it is changed rub the skin with alcohol, ethereal soap, or soap liniment, dry carefully, and examine for excoriations; if any are found, they are anointed with zinc ointment before the dressing is reapplied. The dressing is permanently removed at the end of

four weeks, the arm being worn in a sling for another week. The classical apparatus of Desault is now rarely used. The posterior figure-of-8 bandage associated with the second roller of Desault, some turns being made from the elbow of the injured side to the shoulder of the sound side, can be used in cases in which the forward deformity is apt to return. The apparatus of Fox, which is very useful, consists of a pad for the axilla, a sling for the forearm, and a ring for the opposite shoulder, to which ring are tied the tapes from both the pad and the sling (Fig. 122).

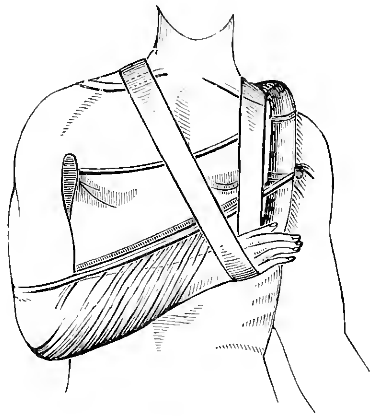


FIG. 122.—Fox's apparatus for fractured clavicle.

The dressing of Moore of Rochester is valuable in an emergency. It consists of a piece of cotton cloth, two yards long, and folded like a cravat until it is eight inches in width at the middle. The center of the bandage rests upon the elbow, the posterior tail is carried across the front of the shoulder of the injured side. The forearm is at an acute angle with the arm, and the other end of the bandage is carried across the forearm, across the back over the opposite shoulder, and around the axilla, where the extremities are stitched together. The forearm is suspended in a bandage sling (S. D. Gross). The four-tailed bandage is preferred by Pick. Sayre's dressing has many advocates (Fig. 123). For this there are required two pieces of rubber plaster, each piece being three inches wide and sufficiently long to go around the chest one and a half times. The end of one piece encircles the arm of the injured side just below the arm-pit; the plaster strip is pulled across the

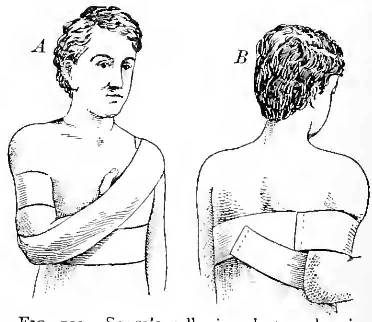


FIG. 123.—Sayre's adhesive-plaster dressing for fracture of the clavicle (Stimson): *A*, first piece; *B*, second piece.

back to the other side, to the front of the chest, and returns again to the middle of the back. This procedure pulls the elbow back and throws the shoulder out. The hand of the injured side is placed on the breast of the opposite side, cotton being interposed, and the second strip of plaster runs from the elbow of the injured side and the opposite shoulder, front, around, and back, pressing the elbow forward, upward, and inward. If the fragments cannot be coaptated, sterilize the parts, administer ether, incise, clear away the muscle from between the fragments, saw the ends, bore each end and hold them in contact by means of kangaroo-tendon or silver wire. The same procedure should be pursued when a fracture is compound or threatens to become so. In three cases in the Jefferson Medical College Hospital the author wired the bones with excellent results.

In any fracture, if signs indicate pressure upon vessels or nerves, or if the fragment has penetrated or seems liable to penetrate the skin, incise, lift the fragments into place and wire them. If the patient refuses this operation, put him to bed and abduct the arm. If a vessel is injured, operation is imperatively necessary. After removing the dressings, if the shoulder is found to be stiff, make passive movements daily; if these fail, move the joint forcibly after giving ether or nitrous oxid.

Fractures of the acromial end of the clavicle are due to direct force. If the fracture is between the two coracoclavicular ligaments, deformity is very slight, crepitus is elicited by manipulating with the fingers, and pain exists, but loss of function is not markedly manifest unless it is due to pain. These fractures are treated by interposing cotton between the arm and the side, binding the arm to the side with the second roller of Desault, and hanging the hand in a sling. In fractures external to the ligaments crepitus is manifest on moving the shoulder, the outline of the bone is irregular, severe pain is developed by movement, and deformity is pronounced. The deformity is due to the serratus magnus muscle rotating the scapula forward, the inner end of the outer fragment of the clavicle often coming in contact with the anterior surface of the outer portion of the inner fragment. Fracture of the acromial end of the clavicle is reduced by pulling both of the shoulders strongly backward, and it is kept reduced by the use of a posterior figure-of-8 bandage. In fracture external to the ligaments the displacement frequently cannot be corrected by position and manipulation.

Such cases demand incision and wiring. In either variety of fracture the dressings are worn for four weeks.

In children, if it is found difficult to immobilize the parts, the most satisfactory result is obtained by the application of the Velpeau bandage, which is to be overlaid by a plaster bandage.

Fractures of the sternal end of the clavicle are very rare. They are caused by either direct or indirect force. In such a fracture there are found crepitus, projection at the seat of fracture, rigidity of the sternomastoid muscle, and shortening of the clavicle. The inner end of the outer fragment always passes forward, and often also downward and inward. Reduce these fractures by pulling the shoulders back, and treat them by means of the posterior figure-of-8 bandage worn for four weeks. Wiring may be necessary.

Fractures of the Scapula.—This bone is not often broken, as it rests upon thick muscles and elastic ribs; it is freely movable, and it has attached to it a bone which easily breaks.

Fractures of the Body.—These are due to direct violence. The *symptoms* are pain (which becomes agonizing on attempting to rotate the shoulder-blade), ecchymosis, and swelling. Crepitus is sought for by placing the hand over the bone and making movements of the arm; also by holding the point of the shoulder and lifting up the lower angle of the bone. The latter plan may develop mobility. The spine of the scapula is uneven only when it itself is fractured. Examine for unevenness of the vertebral border. In fractures of the body of the scapula a shoulder-cap is applied, a gutta-percha splint is moulded over the scapula, the arm is bound to the side, and the hand is carried in a sling. The apparatus is worn for four weeks.

Fractures of the spine of the scapula are treated as are fractures of the body of the bone, and for the same time.

Fractures of the Neck.—Fracture of the *anatomical neck* has not been proved to exist. Fracture of the *surgical neck* is evinced by flattening of the shoulder, prominence of the acromion, and a lump in the axilla, crepitus being developed by pressing the axillary prominence upward and backward. The deformity is reduced with ease, but it at once recurs. It is treated by placing a pad in the axilla, a shoulder-cap on the shoulder, applying the second roller of Desault, and supporting the forearm and elbow in a sling. A Velpeau dressing can be used, associated with a folded towel in the axilla. The dressing is to be worn for five weeks.

Fractures of the glenoid cavity, which are not very un-

usual, may occur with or without dislocation. Fracture of this region arises from direct force applied to the shoulder. The existence of this fracture is determined by excluding fractures of other bones and by detecting crepitus when the arm is at a right angle to the body and the humerus is pushed against the glenoid cavity, the crepitus not being found when the arm hangs by the side.

Treatment is by the second roller of Desault and a forearm sling worn for four weeks; careful passive movements limit ankylosis. If ankylosis occurs, adhesions must be broken up while the patient is under ether or nitrous oxid.

Fractures of the acromion process are often met with as the result of direct violence. The existence of fracture of the acromion is indicated by pain, by inability to abduct the arm, by flattening of the shoulder, by sudden lowering of the point of the shoulder, by mobility, and by crepitus. To treat a case of this kind, put a large pad in the axilla with the base down, bind the arm over the pad with the second roller of Desault, lifting the elbow with turns of the roller carried over it and the opposite shoulder, thus splinting the bone in place by the head of the humerus pushing against the coraco-acromial ligaments. The dressing is to be worn for four weeks.

Fractures of the coracoid process rarely happen alone, and may arise from direct force or from muscular action. But little displacement is found. Crepitus and mobility are usually detected. Inability to shrug the shoulder inward was pointed out as a symptom by Byers. Such a case is well treated by a Velpeau bandage, which is to be worn for four weeks.

Fractures of the humerus are divided into (1) fractures of the upper extremity; (2) fractures of the shaft; and (3) fractures of the lower extremity. In examining any fracture of the humerus, feel at once for the pulse, so as to ascertain if the artery has been torn; in any fracture near the head of the humerus be certain that there is no dislocation.

1. **Fractures of the upper extremity** include (*a*) fractures of the anatomical neck; (*b*) fractures of the surgical neck; (*c*) fractures of the head, oblique and longitudinal; and (*d*) separation of the upper epiphysis.

Fractures of the Anatomical Neck of the Humerus.—The anatomical neck is the constricted circumference of the articular surface, and fractures of it, though rare, do occur, especially in the aged. The line of fracture in some cases

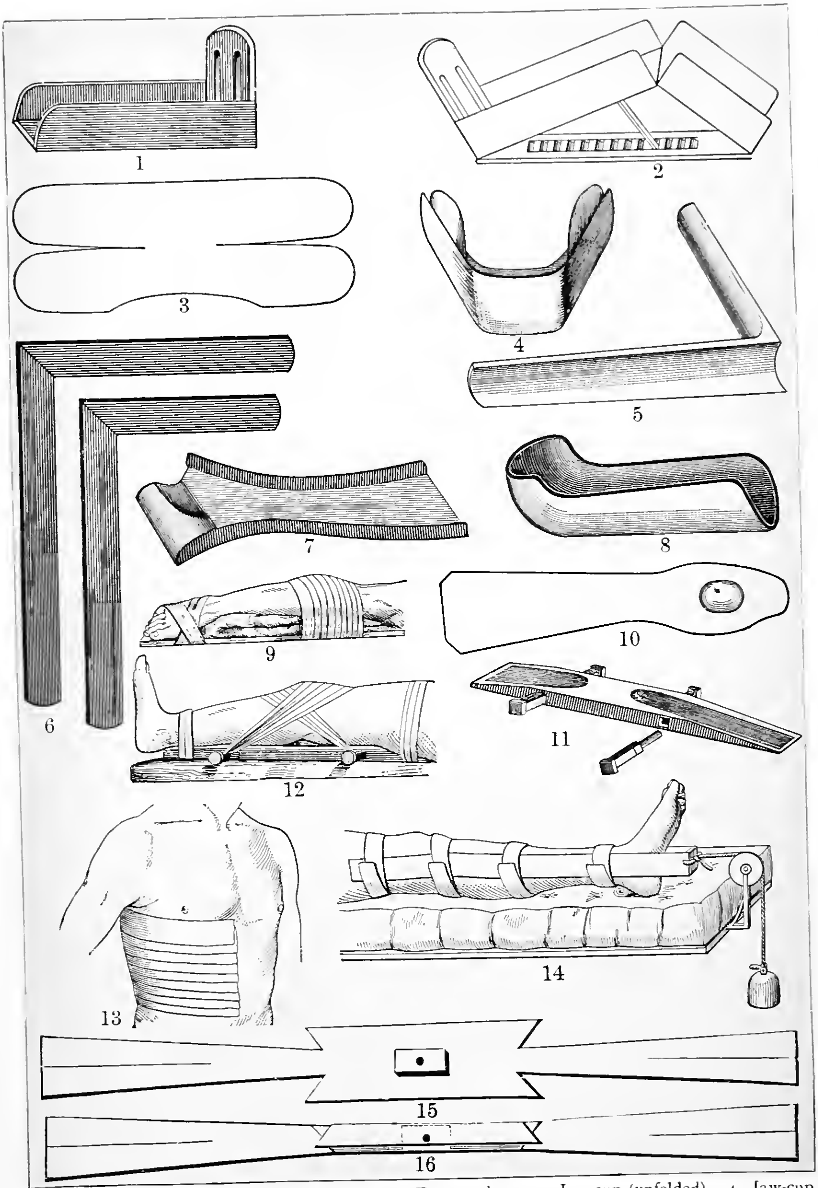
follows the insertion of the capsule, in others it is entirely within the capsule, but in most it is without the capsule above and within the capsule below; hence the term "intra-capsular" is rarely correct as a designation. Such a fracture may be impacted. The *cause* is direct violence or a fal or a blow upon the elbow when the arm is abducted. Polloson of Lyons[1] has reported a case due to muscular action. The patient died in eclampsia, and at the necropsy it was found that both humeral heads were fractured and impacted. The fractures must have been produced by the muscles throwing the heads of the bones violently against the glenoid cavities, probably by adduction.

Symptoms.—The symptoms in fracture of the anatomical neck are pain, swelling, ecchymosis, slight irregularity of the shoulder (which irregularity is soon hidden by tumefaction), and inability to actively abduct the arm. Deformity, as a rule, is slight or is absent, because the capsule is rarely entirely torn from the lower fragment. If deformity exists, it is due to the muscles inserted on the bicipital groove and to the coracobrachialis, which pull the lower fragment inward and forward. Treves says that a tear of the reflected fibers of the capsule leads to subsequent necrosis, because this joint has no ligamentum teres. In some cases impaction occurs, the upper fragment impacting in the lower. In this condition there are very slight shortening and trivial shoulder-flattening, no crepitus unless the tuberosity is broken off, and, as Erichsen says, the head of the bone, while it can be felt through the axilla, is not in the axis of the limb.

The *prognosis* of fracture of the anatomical neck is usually good for bony union (Hamilton, Pick, and R. W. Smith), but a stiff joint is apt to result.

Treatment.—Some surgeons treat this fracture by simply hanging the wrist in a sling and suspending a bag of shot from the elbow to make extension. The usual plan of treatment is as follows: flex the arm to a right angle with the body, and carry up from the base of the fingers to above the elbow the turns of a spiral reversed bandage. Interpose lint between the arm and the side, and place a folded towel or a small pad in the axilla, tying the tapes over the opposite shoulder. Mould a shoulder-cap (Pl. 6, Fig. 8) upon the outer aspect of the arm and upon the shoulder. This cap, which is made of pasteboard or of felt, should reach below the insertion of the deltoid, cover one-half the circumference of the arm, and is to be padded with cotton. The arm with the shoulder-cap is fixed

[1] *Rev. de Chir.*, vol. viii., 1888.



1. Fracture-box. 2. Double Inclined Plane Fracture-box. 3. Jaw-cup (unfolded). 4. Jaw-cup (folded). 5. Anterior Angular Splint. 6. Internal Angular Splint. 7. Bond Splint. 8. Shoulder-cap. 9. Dupuytren Splint in Pott's Fracture. 10. Agnew Splint for Fracture of the Metacarpus. 11. Agnew Splint for Fracture of the Patella. 12. Agnew Splint applied. 13. Strapping the Chest in Fractured Ribs. 14. Extension Apparatus in Fracture of the Femur. 15, 16. Adhesive Strips for Extension Apparatus.

to the side by the second roller of Desault, and the wrist is hung in a sling. The edges of the bandage should be stitched together. This apparatus is changed daily for the first few days, the body and arm being rubbed at each change with alcohol, soap liniment or ethereal soap. After this period a change every third or fourth day is often enough. Passive motion is begun at the end of four weeks, and the dressings are removed at the end of six weeks. In impacted fracture do not pull apart the impaction, but apply a cap to the shoulder and fix the arm to the side for five weeks. No pad is used. The fracture unites with deformity.

Fractures of the Surgical Neck of the Humerus.—The surgical neck is the constricted portion of bone between the tuberosities and the upper line of the insertion of the muscles on the bicipital groove. Fractures in this region are usually transverse, but they may be oblique. The *causes* are—direct force almost always; indirect force occasionally; and muscular action in rare instances.

Symptoms.—The symptoms in fracture of the surgical neck are—pain running into the fingers from pressure upon the brachial plexus; crepitus and mobility on extension; and flattening, which differs from the flattening of dislocation in that it occurs farther below the acromion and that this process is not so prominent. Shortening to the extent of an inch is noted. The head of the bone can be felt in the glenoid cavity, but it does not move on rotating the arm. The upper end of the lower fragment is felt and moves on rotating the arm. The displacement is pronounced. The lower fragment is pulled upward by the deltoid, biceps, coracobrachialis, and triceps; inward by the muscles of the bicipital groove; and forward by the great pectoral; thus, the upper end of the lower fragment projects into the axilla, and the elbow lies from the side and backward. Péan holds that the violence drives the lower fragment forward. The upper fragment is abducted and rotated outward, which position is due, it is generally taught, to the action of the supraspinatus, infraspinatus, and teres minor muscles. In some cases displacement is forward, and in other cases it is not obvious. The lower fragment may impact into the upper, in which case the symptoms are obscure and the diagnosis is made by exclusion. If the impaction is solid and complete, there are the history of direct force, the impaired movements, the slight deformity, and the absence of crepitus. In all fractures of the upper end of the humerus the distinction can be made from dislocation by feeling the head of the bone under

the acromion and by noting that it does not move on rotating the arm.

The *prognosis* of these fractures is good.

Fig. 124.—Internal angular splint and shoulder-cap in fracture of the surgical neck of the humerus.

Treatment.—In treating a case of fracture of the surgical neck, reduce by traction and manipulation; if there is an impaction, pull it apart. Take an internal angular splint (Pl. 6, Fig. 6) and pad it well, putting on extra padding at the points that are to rest against the palm, the inner condyle, and the axillary folds. Lay the arm and pronated forearm upon the splint. Apply a padded shoulder-cap. Fix the splint and cap in place with a spiral reversed bandage terminating as a spica of the shoulder, and hang the hand or forearm in a sling (Fig. 124). The dressing is to be worn for five weeks, and the rules to be followed in changing it are the same as in fractures of the anatomical neck. Motions are to be made after four weeks to amend stiffness. Another plan of treatment is the same as for fracture of the anatomical neck, supporting the wrist only in a sling so as to get the extending weight of the elbow, increasing this weight in some cases by hanging to the elbow a bag of shot. In rare cases—those with strong anterior projection of the lower end of the upper fragment—apply an anterior angular splint. In some cases where the deformity strongly tends to recur support by a

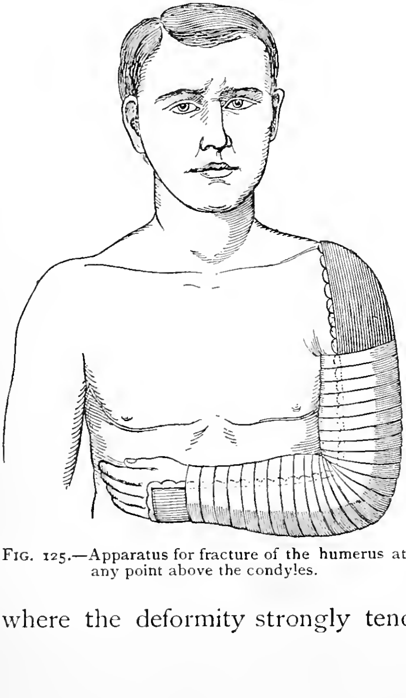


Fig. 125.—Apparatus for fracture of the humerus at any point above the condyles.

plaster-of-Paris trough on the back and sides of arm and shoulder (Fig. 125), or maintain extension by weights and pulleys, the patient being kept in bed (Stimson).

Longitudinal and Oblique Fractures of the Head of the Humerus.—By this term may be designated separation of the great tuberosity, or separation of a portion of the articular surface, together with the great tuberosity, from the shaft and lesser tuberosity (Pickering Pick, Guthrie, and Ogston). The *cause* is direct violence to the front of the shoulder.

Symptoms.—The symptoms in longitudinal and oblique fracture of the head are broadening and flattening of the shoulder with projection of the acromion. The upper fragment passes upward and outward, and the lower fragment passes upward and inward to rest on the margin of the glenoid cavity below the coracoid process. The elbow is drawn from the side, there is some shortening, and the patient cannot abduct his arm. If the elbow be grasped and held to the side and the arm be rotated while the other hand grasps the upper fragment, crepitus is very positive. Examination develops wide separation of the fragments. The deformity cannot be entirely corrected, because the biceps tendon usually gets between the fragments (Ogston), but a useful limb can usually be obtained.

Treatment.—The plan which gives the best result in treating longitudinal and oblique fracture of the head of the bone is to place the patient on his back upon a hard bed with a small firm pillow under his head, abduct the arm above the head, rotate it outward so that the back of the hand rests on the bed, and hold it in place by sand-bags. This position should be maintained for three weeks, at the end of which period the fracture can be dressed for three weeks more as a fracture of the anatomical neck. If the patient refuses to go to bed, treat the injury as a fracture of the anatomical neck, padding well over the tuberosities. The dressings should be worn for six weeks, passive motion being made after four weeks. In all the above injuries—in fact, in all fractures of the humerus—feel at once for the pulse, to see if the artery has been torn.

Separation of the Upper Epiphysis.—The epiphysis is united during the twentieth year, its separation being a rare accident and being produced by direct force.

Symptoms.—The chief symptom in separation of the upper epiphysis is projection of the upper end of the lower fragment inward, forward, and upward beneath the coracoid, and consequently a projection of the elbow backward and from

the side. If the lower fragment passes forward and not inward, the elbow simply passes back. The upper end of the lower fragment is smooth and convex. Rotation of the shaft develops soft crepitus when the fragments are in contact.

The *prognosis* is good for bony union, though the future growth of the limb may be impaired.

Treatment.—The treatment for separation of the upper epiphysis is a pad in the axilla, a shoulder-cap, binding the arm to the side, and hanging the hand in a sling. Wear the dressing for six weeks.

2. **Fractures of the Shaft of the Humerus.**—Fracture of the shaft of the humerus is a very common accident. The *cause* is usually direct violence, such as a blow. The fracture may arise from indirect violence, such as a fall upon the elbow. Muscular action is not rarely also a cause, as in throwing a ball, in catching a tree-limb while falling, or in turning another's wrist as a test of strength (Treves).

The *symptoms* of fracture of the shaft of the humerus are pain, swelling, ecchymosis, inability to move the arm, mobility, and distinct crepitus. Shortening to the extent of three-fourths of an inch occurs. The displacement varies with the situation of the fracture and the direction of the force. If the fracture is above the insertion of the deltoid, the lower fragment is pulled up by the triceps, biceps, and deltoid, and pulled out by the deltoid, and the upper fragment is pulled inward by the arm-pit muscles. In fracture below the deltoid this muscle is apt to pull the lower end of the upper fragment outward, while the lower fragment passes inward and upward because of the action of the biceps and triceps. Injury of the musculospiral nerve sometimes occurs. The nerve may be divided, paralysis occurring in the muscles supplied by it (drop-wrist), or it may be bruised, neuritis resulting. In some cases the nerve is caught in and compressed by the callus.

The *prognosis* is good, but the fact should always be remembered that ununited fractures are commoner in the humerus than in any other bone. Treves believes this to be due to entanglement of muscle between the fragments, lack of fixation of the shoulder-joint, and imperfect elbow-support. Hamilton believes that it is due to the facts that the elbow soon becomes fixed at a right angle, and that any movement of the forearm moves the seat of fracture, and not the elbow.

Treatment.—Reduce the fracture by extension, counter-extension, and manipulation. Apply an internal angular

splint without the shoulder-cap (Fig. 126). If deformity is not corrected, associate with this splint three short humeral splints instead of the shoulder-cap used in fractures near the shoulder-joint. Splints are to be worn for six weeks. Passive movements are not to be made until the fracture is well united (after six weeks), for, if made too soon, they predispose to non-union, and, as no joint is involved, genuine ankylosis will not occur. Many surgeons treat these fractures by applying plaster-of-Paris to the forearm and the arm (the elbow being flexed to a right angle), and hanging a weight to the elbow. Others apply a trough to the arm and forearm (Fig. 125). In any case in which it is impossible to obtain and maintain correct apposition of the fragments cut down upon them, and apply sutures. If the nerve is divided, an incision must be made, and the nerve sutured and the bone wired. If the nerve is caught in the callus, after repair has taken place the nerve must be liberated by chiselling the callus away. Neuritis is treated by blisters over the nerve, the use of the descending galvanic current, and the administration of salicylate of ammonium.

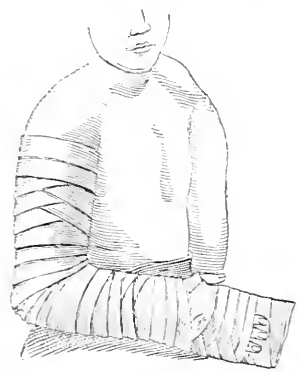


FIG. 126.—Internal angular splint in fracture of the shaft of the humerus.

3. **Fractures of the Lower Extremity of the Humerus.**—These fractures are spoken of as fractures in, or in the neighborhood of, the elbow-joint, and they include (*a*) fractures of the external condyle; (*b*) fractures of the internal condyle; (*c*) fractures of the internal epicondyle; (*d*) fractures at the base of the condyles; (*e*) T- or Y-shaped fractures; (*f*) epiphyseal separation; and (*g*) fractures of the capitellum and trochlea. There may be more than one of these fractures, or there may be also a dislocation of the humerus, of the ulna, or of both bones. Rarely the fracture is compound.

These fractures are frequent injuries. They are rapidly followed by great swelling, and the diagnosis is often very difficult. In most cases, when possible, the *x*-ray should be used in arriving at a diagnosis. In every case in which the *x*-ray is not used, and in most cases in which it is, the surgeon examines the parts carefully while the patient is under ether. If swelling is very great, it is necessary to abate it in

order to reach any conclusion as to the condition. We can bandage the arm, rest it semiflexed on a pillow, and apply evaporating lotions or even an ice-bag for a day or two, or, what is better, temporarily diminish the swelling by Gerster's plan, which is as follows: apply an Esmarch bandage from the hand to well above the seat of fracture; this will drive away extra-articular swelling and permit of thorough examination. It is a great advantage to have the patient anesthetized, for not only can we make an accurate diagnosis, but we can reduce the fracture satisfactorily and apply a careful first dressing.

Fractures of the External Condyle of the Humerus.—A fracture of the external condyle runs into the joint and the capitellum is usually broken off. Such an injury occurs oftenest in children, being due to falling on the hand; but it may occur from direct force, and may happen to adults.

Symptoms.—The symptoms of fracture of the external condyle are severe pain, great swelling, and crepitus (found on pressing or moving the condyle and on rotating the radius). Mobility may also be discovered. A projection is felt on the outer and posterior surface of the elbow. The forearm is semiflexed and supinated. The patient cannot use the joint. The first examination should be made under ether unless an *x*-ray apparatus is accessible; but even when we have a skiagraph of the part the first dressing should be put on under ether.

Fractures of the Inner Epicondyle of the Humerus.—The inner epicondyle is an epiphysis which unites during the seventeenth year. It not infrequently breaks from muscular action or from direct violence, the fracture not involving the joint. Crepitus and mobility can be detected. Displacement is slight. The *outer epicondyle* is never fractured alone.

Fractures of the Internal Condyle of the Humerus.—The line of fracture after a break of the internal condyle runs into the joint, to the trochlear surface of the humerus. The *cause* is always direct violence.

Symptoms.—In fracture of the internal condyle the fragment, accompanied by the ulna, goes upward and backward, and when the forearm is extended the ulna projects posteriorly, the lower end of the humerus being felt in front. The fragment forms a projection back of the elbow. Crepitus and preternatural mobility can be found if swelling is not too great. Crepitus is detected by flexing and extending the forearm. The space between the condyles is broader than normal, and the forearm takes a bend toward the ulnar side,

the "carrying function" of the forearm being lost. When a person carries a heavy object, such as a bucket, he instinctively rests the inner condyle upon the pelvis, and the normal deviation of the forearm outward keeps the bucket from striking the leg. This deviation outward when the inner condyle rests against the ilium gives us the carrying function. In fracture of the inner condyle the broken condyle ascends and the "carrying function" is lost (Fig. 127).

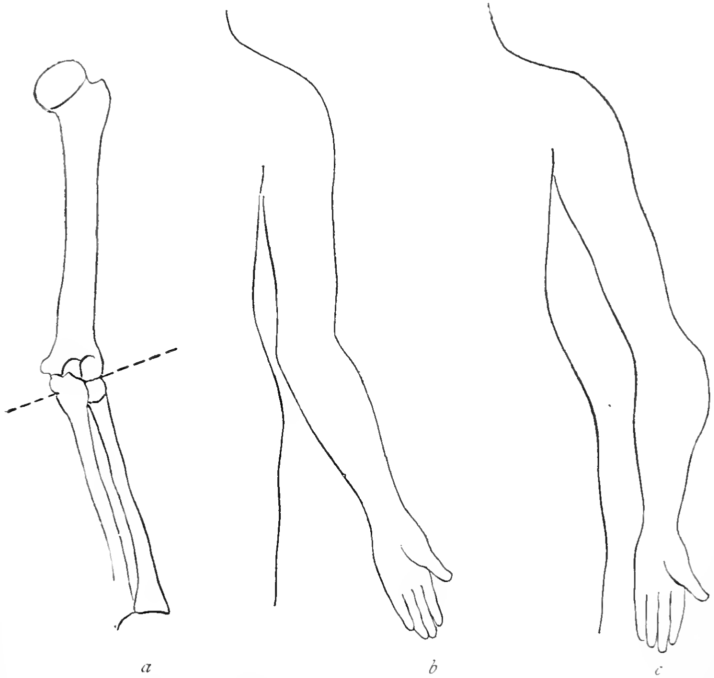


FIG. 127.—Diagram to exhibit the "carrying function" of the forearm, and the loss of this function in fracture of the inner condyle of the humerus: *a* and *b* show the normal relation of the parts when carrying; *c* shows the alteration of axis of the forearm when the inner condyle is fractured, what is known as gun-stock deformity resulting (after Allis).

Fractures at the Base of the Condyles of the Humerus.—A fracture in this region is just above the olecranon and is on a higher level behind than in front. The *cause* is direct force acting upon the olecranon.

The *symptoms* are loss of function and pain from injury of the median or ulnar nerve. Crepitus and mobility are readily found. The lower fragment goes backward and upward by the action of the triceps, biceps, and brachialis anticus muscle. The lower end of the upper fragment projects in front of the

joint. This lesion may be mistaken for dislocation of the bones of the forearm backward. In fracture the limb is mobile; in dislocation it is rigid. In fracture the deformity is easily reduced and strongly tends to recur; in dislocation the deformity is reduced with difficulty and does not tend to recur. In dislocation there is shortening of the forearm but not of the arm; in fracture there is shortening of the arm but not of the forearm. In dislocation there is a smooth large projection below the crease in front of the elbow; in fracture there is a sharp projection above the crease. In fracture there is crepitus; in dislocation there is no crepitus.

The *diagnosis* can usually be settled by the Röntgen rays.

T-fractures of the Humerus.—A T-fracture consists of a transverse fracture above the condyles plus a vertical fracture between them. The *cause* is violent direct force applied posteriorly.

Symptoms.—The symptoms are increase in breadth of the joint, preternatural mobility, crepitus, pain and swelling, mounting up of the inner condyle back of the elbow on the inner side, and of the outer condyle back of the elbow on the outer side. The forearm is semiflexed and supinated, and the carrying function is lost.

Prognosis of Fractures In or Near the Elbow-joint.—In many fractures it is difficult or impossible to obtain reduction, and in some it is impossible to maintain reduction. Stimson is undoubtedly right when he says that "in intercondyloid fracture with marked separation there is no practicable means merely to maintain reduction."[1] The prognosis for complete restoration of function is bad, and in most of these fractures some deformity and considerable stiffness are inevitable. Ankylosis partial or complete is a not unusual sequence. Ankylosis may result from prolonged immobilization, the muscles contracting and becoming fibrous, the fascia and ligaments about the joint shortening, the capsule shrinking and thickening, some of the cartilages becoming fibrous, and the joint being partly obliterated. It may result from ex-

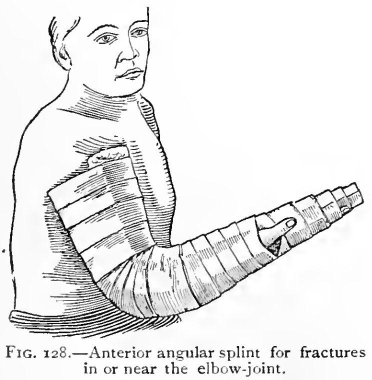


FIG. 128.—Anterior angular splint for fractures in or near the elbow-joint.

[1] *Transactions American Surgical Association*, vol. ix.

travasation of blood into the joint and tendon-sheaths with subsequent formation of fibrous tissue. It may arise from the organization of inflammatory exudate within and about the joint and in the sheaths of muscles and tendons. It may arise from the formation of an excess of callus. Bruns claims that in fracture in the joint excess of callus rarely forms, and that masses of callus form chiefly in the line of fracture near but not in a joint.[1] Excessive callus-formation is sure to take place if reduction is not thoroughly accomplished or if the fragments are not well immobilized but move upon each other. A mass of callus in or about a joint acts like a stone pushed into the crack of a door—it limits or prevents motion.

Treatment of Fractures In or Near the Elbow-joint.—Thoroughly set the fracture while the patient is under ether. It is advisable, when it can be done conveniently, to use the *x*-rays to confirm the diagnosis and to use them again after dressings have been applied, to be sure that the fracture remains in good position. Some surgeons advocate dressing the fracture on an anterior angular splint, the forearm being fully supinated. The advantage claimed for this splint is that if ankylosis occurs the joint is in a position to be useful, which it is not if ankylosed in extension. Some deformity is usually apparent after treating a case with this splint; the deformity following fracture of the inner condyle is not corrected by it, but if the splint is carefully applied the result is usually a useful extremity. The splint must not be applied when there is great swelling, and swelling must be removed by resting the extremity on a pillow, the elbow being semiflexed, applying evaporating lotions or even an ice-bag, employing massage, and gently compressing by bandaging. In some cases the joint should be aspirated. In order to apply this dressing, take a right-angled splint and pad its outer surface, being careful to place thick, soft pads over the convexity which will press in front of the elbow and over each end of the splint. Fasten the upper end to the arm, then make extension of the forearm, and if the fracture is found to be well reduced, fasten the hand and forearm to the splint (Fig. 128). If the hand and forearm are first fixed to the splint, there will be no extension from the elbow and deformity will result. If posterior projection exists, a pasteboard cup is moulded over the elbow. The extremity is hung in a triangular sling. At night the extremity is kept in the sling or laid on a pillow. Every third or fourth day, while the extremity is carefully steadied, the splint is removed, the arm and

[1] Max Oberst, in Volkmann's *Sammlung Vorträge.*

forearm well rubbed with alcohol, massaged, and the splint reapplied. The splint is worn for four weeks. Some surgeons prefer to obtain a right-angled position of the elbow by the use of a posterior trough. At the end of the second week, while the dressings are off, slightly flex and slightly extend the forearm, and slightly pronate it, and reapply the splint. At the end of the third week repeat this maneuver, making greater movements. In the middle of the fourth week and at the end of the fourth week do it again, and flex and extend as much as possible. Very early and very frequent passive motion is objectionable, as it leads to overproduction of callus and ankylosis, but passive motion as above described is imperatively necessary. Many surgeons at the end of the second week apply a Stromeyer splint, which permits the patient and the surgeon to make some motion by means of the screw without removing the dressings. In very stout people an anterior angular splint will not stay in place. In such a case the forearm may be placed at a right angle to the arm and plaster-of-Paris be used. After the dressings are removed employ passive motion, massage, hot and cold douches, inunctions of ichthyol or mercurial ointment, iodin locally, corrosive sublimate and iodid of potassium internally, and direct the patient to systematically use the arm. If in any case after four weeks non-union exists, put up the arm in a plaster splint for three or four weeks more.

Allis warmly advocates treatment in extension. He holds that the extended position secures the best circulation, and if either condyle is unbroken gives us a natural splint. Furthermore, in fractures of the inner condyle, it restores the carrying function, which the flexed position does not do. For one week after the accident the patient stays in bed, with his arm extended upon a pillow. After swelling subsides the limb is wrapped firmly in a spiral flannel bandage and plaster is rubbed in or the bandage is covered with adhesive plaster.

Some surgeons extend the limb and apply an ordinary plaster bandage, and in about three weeks substitute an anterior angular splint. The trouble with treatment in extension is that if ankylosis ensues the limb is nearly useless. Furthermore, treatment by extension requires confinement to bed.

Jones of Liverpool thinks that splints and bandages are largely responsible for the stiffness which so commonly ensues upon an elbow injury. He advocates treatment by acute flexion in all elbow injuries except fracture of the olecranon.

In a fracture of the humerus he extends, supinates, and flexes the forearm to reduce the displacement. He maintains flexion by fastening a bandage around the wrist and neck. The bandage around the neck passes through a rubber tube, which serves to protect the neck. The ball of the thumb should rest against the neck. The bandage is fastened to a leather band around the wrist. This position is maintained from three to six weeks.[1] The author has treated a number of cases by Jones's method, and now prefers it to any other plan.

FIG. 129.—Frazier's modification of Jones's dressing for injuries of the elbow-joint.

The most convenient dressing to maintain Jones's position was devised by Frazier; it is shown in Fig. 129.

If it is found impossible to reduce the fragments or to maintain reduction, we should follow the advice of John B. Roberts, make an incision and nail the fragments in place.

In young children the anterior angular splint must not be used. It will become loosened, and motion will inevitably take place at the seat of fracture. Such cases can be treated satisfactorily in Jones's position with Frazier's sling, or we can treat them in extension. Bertomier's plan is very useful in young children.[2] The extremity is dressed without pressure in extension and supination. This can be effected by flannel bandages. In from four to eight days a silicate of sodium bandage is applied in order to prevent pronation. About the sixteenth day the bandage is cut so as to form two troughs. From this period every third day the splints are removed and gentle passive motion is made. The splints are removed permanently at the end of four weeks.

If false ankylosis follows fracture, the adhesions should be broken up under ether, and for some time passive motion should be made daily after the use of the hot-air apparatus. In true ankylosis an operation should be performed and the interlocking callus or the interposed tissue or fragment removed, if a skiagraph shows that operation promises success.

[1] *Provincial Medical Journ.*, Dec., 1894, and Jan., 1895.
[2] *Revue de Chir.*, vol. viii., 1888.

If gunstock deformity results and produces marked disablement, it should be operated upon. An osteotomy is performed on the inner condyle. The arm is set in the extended position, plaster of Paris is applied, and is not removed for six weeks.[1]

Separation of the lower epiphysis of the humerus is a not unusual accident. The inferior extremity of the humerus may be separated, or the condyles may be separated from each other and from the shaft of the bone.

Symptoms.—The symptoms are—prominence in front of the joint, caused by the lower end of the shaft of the humerus; projection backward of the olecranon; the forearm rests midway between pronation and supination. Epiphyseal separation may retard growth and produce deformity.

Treatment.—Jones's position or anterior angular splint as above directed.

Fractures of the ulna comprise the following varieties: (1) fracture of the coronoid process; (2) fracture of the olecranon process; (3) fracture of the shaft; and (4) fracture of the styloid process.

Fractures of the coronoid process of the ulna are rarely observed, and practically occur only as a complication of backward dislocation of the ulna or in association with other fractures.

Symptoms.—When fracture of the coronoid process is associated with a dislocation crepitus is appreciated on reduction, and it is found that the deformity of the dislocation promptly returns on cessation of extension. The upper fragment may be pulled upward by the brachialis anticus muscle, and there exists an inability to flex the forearm completely. The position is one of extension with posterior projection of the olecranon. The broken piece is felt in front of the joint.

Treatment.—The treatment is by an anterior splint whose angle is less than a right angle; the splint is to be worn for four weeks, and passive motion is to be begun in the third week. Jones's position may be used in treating such a case. A stiff joint may follow.

Fractures of the olecranon process of the ulna occur not uncommonly in adults. Hulke states that such a fracture never occurs before the age of fifteen, but the writer has seen in the Jefferson Medical College Hospital a girl aged fourteen with a fractured olecranon. The *cause* is direct violence or muscular action. Only a small fragment may be

[1] G. G. Davis, *Phila. Med. Jour.*, May 13, 1899.

torn away, or the entire olecranon may be broken off, and the break may be comminuted or may even be compound.

Symptoms.—The symptoms of fracture of the olecranon are—swelling; partial flexion of the forearm; separation of the fragments, the upper piece being pulled up from half an inch to two inches by the triceps; the space between the fragments is increased by forearm flexion and lessened by forearm extension; there is inability to extend the arm. Bulging of the triceps above the fragments and crepitus on approximating the fragments are observed. In some few cases there is no separation, the periosteum being untorn or the fascial expansions from the triceps holding the fragments in apposition. In such cases crepitus can be elicited by rocking the upper fragment from side to side.

The *prognosis* is fair, fibrous union being the rule. Some joint-stiffness usually occurs, and much ankylosis may be unavoidable.

Treatment.—Fracture of the olecranon is treated with a well-padded anterior splint, almost but not quite straight. A perfectly straight splint is uncomfortable, and, by opening a retiring angle between the fragments and into the joint, favors non-union and ankylosis. The splint should reach from a level with the axillary margin to below the fingers. If the upper fragment does not come in contact with the lower, pull it down by adhesive plaster and fasten the strips to the splint. The author in one case employed a glove to which strings from the adhesive plaster were attached. After applying the splint keep the patient in bed for three weeks. The danger of ankylosis in this fracture is very great, and, in case it occurs in the position of extension, an almost useless arm results. Follow the rule of T. Pickering Pick, and at the end of three weeks anesthetize the patient, press the thumb firmly down upon the top of the olecranon, put the forearm at a right angle, and apply an anterior angular splint and direct it to be worn for two weeks. When the anterior splint has been applied passive motion should be made every other day, or every third day, and massage should be used at the same time. When the splint is removed try to increase the range of motion as previously directed. Non-union requires wiring of the fragments.

Fractures of the shaft of the ulna alone are usually near the middle of the bone, are always due to direct violence, and are not unusually compound. An injury which breaks the ulna is very apt to break the radius also.

Symptoms.—By running the finger along the inner surface

of the bone there are detected inequality and depression; crepitus and mobility are easily developed; there are pain and the evidence of direct violence. The long axis of the hand is not on a line with the long axis of the forearm, but is

Fig. 130.—Fracture of the shaft of the ulna (case in the Pennsylvania Hospital; skiagraphed by Dr. Gaston Torrance).

internal to it. If deformity exists, it is due to the lower fragment passing into the interosseous space because of the action of the pronator quadratus muscle; the upper fragment, acted on by the brachialis anticus, passes a little forward (Fig. 130). The forearm at and below the seat of fracture is narrower and thicker than normal.

Treatment.—In treating fracture of the shaft of the ulna place the forearm midway between pronation and supination, so as to bring the fragments together and to obtain the widest possible interosseous space, and thus limit the danger of union taking place between the radius and ulna. The position midway between pronation and supination is obtained by flexing the forearm to a right angle with the arm and pointing the thumb to the nose. Take two well-padded straight splints, one long enough to reach from the inner condyle to below the fingers, the other from the outer condyle to below the wrist; place a long pad of lint over the interosseous space on the flexor side of the limb, and another on the extensor side; apply the splints and hang the arm in a triangular sling (Fig. 131). Passive motion is to be made in the third week, and the splints are to be worn for four weeks. Fractures of the ulna can be treated very efficiently with plaster of Paris.

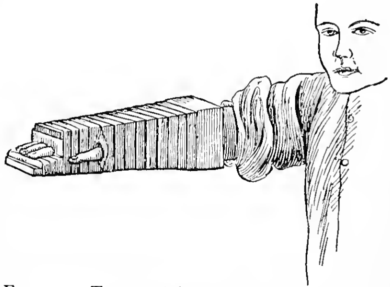


FIG. 131.—Two straight splints in fracture of both bones of the forearm.

Fractures of the styloid process of the ulna are due to direct force. The displacement is obvious.

Treatment.—In treating fracture of the styloid process push the fragment back into place and use a Bond splint with a compress for four weeks, or a plaster-of-Paris dressing.

Fractures of the radius include the following varieties: (*a*) fractures of its head; (*b*) fractures of its neck; (*c*) fractures of its shaft; and (*d*) fractures of its lower extremity.

Fracture of the head of the radius very rarely occurs alone, but it may complicate backward dislocation of the radius.

Symptoms.—The symptoms of fracture of the head of the radius are crepitus on passive pronation and supination, and loss of voluntary pronation and supination.

Treatment.—The treatment of a fracture of the head of the radius is the same as for a fracture in or near the elbow-joint, namely, an anterior angular splint for four or five weeks, or placing the extremity in Jones's position.

Fracture of the neck of the radius very rarely occurs alone.

Symptoms.—In this fracture the forearm is pronated and the patient is found to have lost the power of voluntary pronation and supination. Under forced pronation and supination it will be noted that the head of the radius does not move and crepitus is felt. The lower fragment, being pulled upward and forward by the biceps, can be felt in front of the elbow-joint.

Treatment.—The treatment for fracture of the neck of the radius is the same as for fracture of the elbow-joint—namely, an anterior angular splint or Jones's position.

Fracture of the shaft of the radius is far commoner than fracture of the shaft of the ulna. It may occur above or below the insertion of the pronator radii teres muscle. It may arise from either direct or indirect force. Fracture of the shaft of the ulna may coexist as a result of the same accident.

Fracture of the Radius above the Insertion of the Pronator Radii Teres Muscle.—*Symptoms.*—The upper fragment is drawn forward by the biceps and is fully supinated by the supinator brevis. The lower fragment is fully pronated by the pronator quadratus and pronator radii teres, and its upper end is pulled into the interosseous space. There are crepitus, mobility, pain, narrowing and thickening of the forearm below the seat of fracture, and loss of the power of pronation and supination. The head of the bone is motionless during passive pronation and supination. The hand is prone.

Treatment.—In treating this fracture do not put the forearm midway between pronation and supination, as this position will not bring the fragments into contact, the upper fragment remaining flexed and supinated. To bring the lower fragment in contact with the upper, flex and fully supinate the forearm. Apply an anterior angular splint to the extremity for four weeks, and make passive motion in the third week.

Fracture of the Radius below the Insertion of the Pronator Radii Teres Muscle.—In this variety of fracture the upper fragment is acted on by the biceps, the supinator brevis, and the pronator radii teres, and it remains about midway between pronation and supination, passing forward and also into the interosseous space. The lower fragment is acted on by the supinator longus and the pronator quadratus, the latter being the more powerful of the two, and the lower fragment is moderately pronated, its upper extremity being drawn into the interosseous space. Other symptoms

are identical with those of fracture above the insertion of the pronator radii teres.

Treatment.—In treating fracture below the pronator radii teres the forearm is flexed and is placed midway between pronation and supination; two interosseous pads and two straight splints are applied as for fracture of the ulna (Fig. 131). The splints are worn for four weeks, and passive motion is made in the third week. Plaster of Paris is a most satisfactory dressing.

Fracture of the shafts of both bones of the forearm is not frequently seen. It is caused by direct or indirect force.

Symptoms.—In fracture of both bones of the forearm the hand is pronated and the lower two fragments come together and are drawn upward and backward or upward and forward by the combined force of flexor and extensor muscles, shortening being manifest and the projection of the lower fragments being detected on either the dorsal or the flexor surface of the forearm. The upper fragment of the ulna is somewhat flexed by the brachialis anticus; the upper fragment of the radius is flexed by the biceps and is pronated and drawn toward the ulna by the pronator radii teres. The forearm is narrower than it should be (the ends of the fragments having passed into the interosseous space) and is thicker than normal from front to back (the contents of the interosseous space having been forced out). Crepitus, mobility, pain, and inequality exist, the power of rotation is lost, and on passive rotation the head of the radius does not move. The forearm is prone and semiflexed.

Treatment.—The treatment consists in the application of two straight splints and two interosseous pads, the forearm being flexed to a right angle and placed midway between pronation and supination (Fig. 135). The splints are worn for four weeks, and passive motion is made in the third week. Instead of these splints, a plaster-of-Paris dressing can be used.

Fractures of the Lower Extremity of the Radius.—*Colles's fracture* is a transverse or nearly transverse fracture of the lower end of the radius, between the limits of one-quarter of an inch and one and a half inches above the wrist-joint, the lower fragment sometimes mounting upon the dorsum of the upper fragment. An oblique fracture beginning within half an inch of the joint and passing into the joint is known as *Barton's fracture.* Colles's fracture was first recognized as a fracture by Colles, of Dublin, in 1814. Before this time the injury was called backward dislocation of the wrist. It is a very common injury, is met with most

frequently in those beyond the age of forty, and oftener in women than in men. It is due to transmitted force (a fall upon the palm of the pronated hand). Some think that the force is received by the ball of the thumb and passes to the carpal bones and the edge of the radius; a fracture begins posteriorly rather than anteriorly, the force driving the fragment upon the dorsal surface of the radius, the carpus and lower fragment moving upward and outward. It is much more likely that this fracture is due to cross-strain on the bone. There is sudden traction upon the anterior ligaments, which drag upon the bone and break it at a point where the cancellous end of the radius joins the compact shaft (Fig. 132). The fragments are not unusually impacted. In the author's experience dislocation of the lower end of the ulna is a not unusual complication, which arises from a fracture of the ulnar styloid or tearing off of the internal lateral ligament of the wrist.

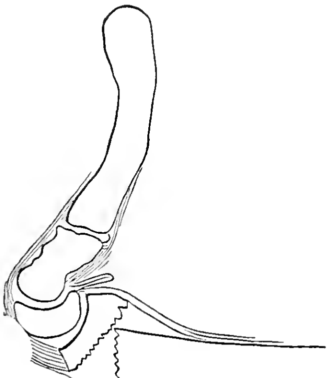
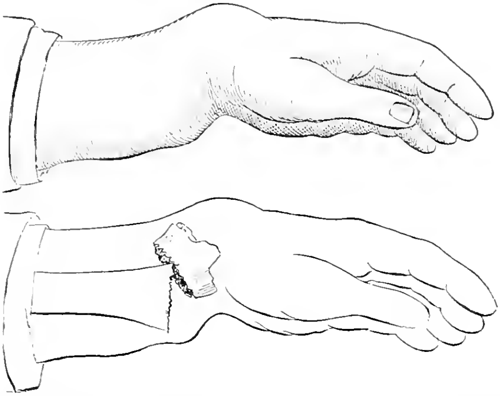


Fig. 132.—Effect upon the lower end of the radius of the cross-breaking strain produced by extreme backward flexion of the hand (Pilcher).

Symptoms.—In Colles's fracture the hand is abducted (drawn to the radial side of the forearm) and pronated, the head of the ulna is prominent, the styloid process of the radius is raised, and the lower fragment may mount on the back of the lower end of the upper fragment, causing a dorsal projection, termed by Liston the "silver-fork deformity." The lower end of the upper fragment can be felt beneath the flexor tendons above the wrist. The position in deformity is produced by the force. Some consider it is maintained by the action of the supinator longus and the flexor and extensor muscles, but particularly by the extensors of the thumb. Pilcher has demonstrated the fact that in this fracture a portion of the dorsal periosteum is untorn, and this untorn portion acts as a binding band to hold the fragments in deformity. Pronation and supination are lost. In this fracture the hand can be greatly hyperextended (Maisonneuve's symptom). Crepitus, which is best obtained by alternate hyperextension and flexion, can be secured

unless swelling is great or impaction exists. Crepitus on side movements is rarely obtainable. Impaction may greatly



FIGS. 133, 134.—Deformity at the wrist consequent upon displacement backward of the lower fragment of the radius after fracture at its lower extremity (Levis).

modify the deformity, though displacement generally exists to some extent, and the fragments do not ride easily on each

FIG. 135.—Colles's fracture of the radius (Pennsylvania Hospital case; skiagraphed by Dr. Gaston Torrance).

other. The styloid process of the ulna may be broken, or the inferior radio-ulnar articulation may be separated. This

latter complication allows the lower fragment to roll freely upon the upper, and the characteristic silver-fork deformity does not appear. If the styloid process of the ulna is broken, pressure over it causes great pain. If a person in falling strikes the back of the hand and a fracture of the radius occurs, the lower fragment is driven upon the front surface of the upper fragment and is felt under the flexor tendons at the wrist. An elaborate study of fracture of the radius with forward displacement of the lower fragment has been published by John B. Roberts.[1]

Treatment.—In treating Colles's fracture reduce the deformity by hyperextension to unlock the fragments and relax

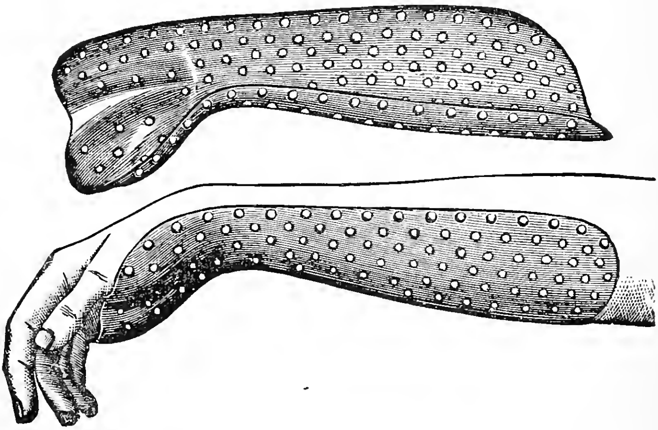


FIG. 136.—Levis's radius-splints, right and left, for fracture of the lower end of the radius.

the dorsal periosteum, and follow by longitudinal traction to separate the fragments, and forced flexion to force them into position. This formula was introduced many years ago by the late R. J. Levis. It is of the first importance to thoroughly reduce this fracture, and very often it is not thoroughly reduced. Imperfect reduction means permanent deformity, stiffness of the tendons and wrist, and possibly an almost useless hand. The extremity can be placed upon a Levis splint (Fig. 136), the position maintaining reduction and the tense extensor tendons giving dorsal support. Some surgeons use Gordon's pistol-shaped splint. The favorite splint in Philadelphia practice in the past has been Bond's (Fig. 137). It places the hand in a natural position of rest

[1] *Am. Jour. Med. Sci.*, Jan., 1897.

(semiflexion of the fingers, semi-extension of the wrist, and deviation of the hand toward the ulna). Two pads are used: a dorsal pad which overlies the lower fragment, and a pad for the flexor surface which overlies the lower end of the upper fragment. A bandage is applied, the thumb and fingers being left free (Fig. 84; Pl. 6, Fig. 7). Passive motion is begun upon the fingers in three or four days, and upon the wrist during the second week. The splint is removed in three weeks, and a bandage is worn for a week or two more because of the swelling. In applying the Bond splint, do not pull the hand too much up on the block, or the fracture will unite with a projection upon the flexor surface of the extremity and the tendons of the wrist will be apt to be caught in the callus. The most satisfactory dressing is the straight dorsal splint advised by Roberts. It prevents the recurrence of deformity (Fig. 138) and is mechani-

FIG. 137.—Bond's splint in Colles's fracture.

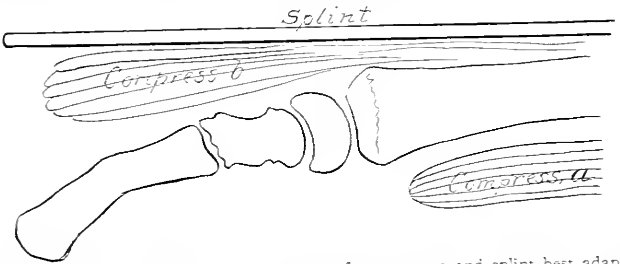


FIG. 138.—Diagram showing the arrangement of compresses and splint best adapted to retain fragments in proper position after reduction (Pilcher).

cally the proper mode of treatment. It should be worn for three weeks. Undoubtedly more or less stiffness often follows Colles's fracture, and some very able surgeons have been so impressed with the frequency of its occurrence that they have dispensed with the use of a splint. Sir Astley Cooper long ago spoke of placing the arm in a sling as proper treatment for fracture of the radius. Moore, of Rochester, applied a cylindrical compress over the ulna, held in place for six hours with adhesive plaster, then cut the plaster, placed the forearm in a sling, and let the hand hang

over the edge of the sling. Pilcher applies a band of adhesive plaster around the wrist and supports the wrist in a sling. Storp says that dispensary patients are apt to disarrange this dressing.[1] He wraps a piece of rubber plaster four inches wide around the wrist, and places a second piece around the first so arranged as to form a fold over the radius; an opening is made through the fold for the passage of a sling. In ten days the plaster is removed and the forearm is carried in a sling. If a stiff joint and limited tendon-motion eventuate from the fracture, use massage, frictions, sorbefacient ointments, tincture of iodin, electricity, hot and cold douches, and the hot-air apparatus, or give ether and forcibly break up adhesions. If reduction was not thoroughly effected and too great a length of time has not elapsed, and the hand is helpless and painful, the bone should be refractured. In a young or middle-aged person, in whom a useless hand has followed an ill-reduced fracture, osteotomy is justifiable.

Fracture of both the Radius and Ulna near the Wrist.—Colles's fracture may be complicated by a fracture of the ulna other than of its styloid process.

Symptoms.—In fracture of the radius and ulna near the wrist the lower ends of the upper fragments come together, the upper fragment of the radius is pronated, and the lower fragment of the radius is drawn up. Pain, crepitus, mobility, shortening, and loss of function exist.

Treatment.—Fracture of the radius and ulna near the wrist should be treated with the straight dorsal splint, as in Colles's fracture.

Separation of the Lower Radial Epiphysis.—This accident occurs in children from falling upon the palm of the hand. It never happens after the twentieth year.

Symptoms.—In separation of the lower radial epiphysis the lower fragment mounts upon the upper and produces a dorsal projection like Colles's fracture, but the hand does not deviate to the radial side. The deformity resembles that of a backward carpal dislocation, but is differentiated from dislocation by the unaltered relation in the fracture between the styloid processes and the carpal bones.

Treatment.—The treatment in separation of the lower radial epiphysis is the same as for Colles's fracture.

Fractures of the carpus are not frequent, and they are usually compound. The *cause* is violent direct force.

Symptoms.—Fractures of the carpus are indicated by pain,

[1] *Arch. f. klin. Chir.*, liii.

swelling, evidences of direct force, sometimes crepitus, loss of power in the hand, and a very little displacement.

Treatment.—Many compound comminuted fractures of the carpus require amputation. In an ordinary compound fracture, asepticize, drain, dress with antiseptic gauze and a plaster-of-Paris bandage, cutting trap-doors in the plaster over the ends of the drainage-tube. In a simple fracture dress the hand upon a well-padded straight palmar splint (Pl. 5, Fig. 10) reaching from beyond the fingers to the middle of the forearm, and place the hand and forearm in a sling. The splint is worn for four weeks, and passive motion of the wrist is begun in the second week.

Fractures of the Metacarpal Bones.—Fracture of the metacarpus is very common. One or more bones may be broken. The first metacarpal bone is oftenest broken; the third is rarely broken (Hulke). The *cause* is direct or indirect force.

Symptoms.—The signs of a metacarpal fracture are—dorsal projection of the upper end of the lower fragment or the lower end of the upper fragment; pain; crepitus; and often evidences of direct violence.

Treatment.—To treat a fracture of a metacarpal bone reduce by extension; place a large ball of oakum, cotton, or lint in the palm to maintain the natural rotundity, and apply a straight palmar splint like that used for fracture of the carpus (Pl. 6, Fig. 10). It may be necessary to apply a compress over the dorsal projection. The duration of treatment is three weeks, and passive motion is begun after two weeks. A plaster-of-Paris dressing is often used.

Fractures of the Phalanges.—The phalanges are often broken. The fracture may be compound. The *cause* usually is direct force.

Symptoms.—Fracture of the phalanges is indicated by pain, bruising, crepitus, and mobility, with very little or no displacement.

Treatment.—If the middle or distal phalanx is broken, mould on a trough-like splint of gutta-percha or of pasteboard, which splint need not reach into the palm. If the proximal phalanx is broken, carry the splint into the palm of the hand. Make the splint of gutta-percha, pasteboard, wood, or leather. The splint is worn three weeks. A sling must be worn, otherwise the finger will constantly be knocked and hurt. Some cases require a dorsal as well as a palmar splint. These cases are dressed most satisfactorily with a silicate-of-sodium or plaster-of-Paris bandage.

Fracture of the femur is a very common injury. The

divisions of the femur are (1) the upper extremity; (2) the shaft; and (3) the lower extremity.

1. **Fractures of the upper extremity of the femur** are divided into (*a*) intracapsular; (*b*) extracapsular; (*c*) of the great trochanter; and (*d*) epiphyseal separation (either of the great trochanter or the head).

Intracapsular Fracture of the Femur.—This fracture of the neck is transverse or only slightly oblique (Fig. 139),

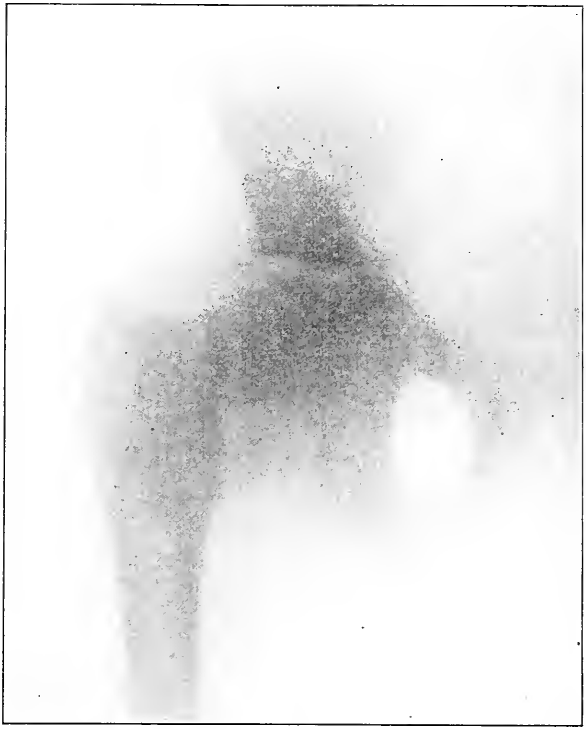


FIG. 139.—Intracapsular fracture of the hip (Pennsylvania Hospital case; skiagraphed by Dr. Gaston Torrance).

and is not unusually impacted. The *cause* is often slight indirect force, of the nature of a twist, acting upon a person of advanced years (more often a woman than a man), but not unusually a fall upon the great trochanter is the cause. A fall upon the knees, a trip, or an attempt to prevent a fall may produce this fracture. It often happens that the fall is due to the fracture rather than that the fracture arises from the

fall. Intracapsular fracture is never caused by direct force unless it is due to gunshot violence. The aged are more liable to intracapsular fracture than the young or the middle-aged, because, first, the angle which the neck forms with the axis of the femur becomes less obtuse with advancing years, and may even form a right angle; this change is more pronounced in women than in men; secondly, the compact tissue becomes thinned by absorption, the cancelli diminish, the spaces between them enlarge, the bony portions of the cancellous structure are thinned or destroyed, and the cancellous structure becomes fatty and degenerated. Sutton has shown that in very rare cases this fracture may occur in the young, even before the union of the epiphyses. Stokes follows Gordon of Belfast in classifying fractures of the femoral neck. He divides them into intracapsular and extracapsular, and subdivides intracapsular fractures into fracture with penetration of the cervix into the head; fracture with reciprocal penetration; intraperiosteal fracture at the junction of the cervix and head; intraperiosteal fracture of the center of the cervix; extraperiosteal fracture, with laceration of the cervical ligaments. The last-named fracture is the most common. The first four forms may unite by bone, the fifth form will not because of non-apposition, lack of nutrition, effusion of blood, synovitis, or interstitial absorption.[1] Stokes claims that we may have penetration, but not impaction.

Symptoms.—In intracapsular fracture there is usually shortening to the extent of from half an inch to an inch; but in some cases no shortening can be detected. Shortening of a quarter of an inch does not count in making a diagnosis, for one limb is often naturally a little shorter than the other. If the reflected portion of the capsule is not torn, the shortening is trivial in amount or is entirely absent. In some cases shortening gradually or suddenly increases some little time after the accident. This is due to separation of a penetration, tearing of the previously unlacerated fibrous synovial reflection, or restoration of muscular strength after a paresis. A gradually increasing shortening arises from absorption of the head of the bone. Shortening is due chiefly to pulling upon the lower fragment by the hamstrings, the glutei, and the rectus.

Pain is usually present anteriorly, posteriorly, and to the side. The area of pain is localized, and motion or pressure greatly increases the suffering.

[1] Stokes, in *Brit. Med. Jour.*, Oct. 12, 1895.

Eversion exists, spoken of as "helpless eversion," though in a very few instances the patient can still invert the leg. This eversion is due to the force of gravity, the limb rolling outward because the line of gravity has moved externally. That eversion is not due to the action of the external rotator muscles, as was taught by Astley Cooper, is proved by the fact that when a fracture happens in the shaft below the insertion of these muscles the lower fragment still rotates outward. This is further demonstrated by the considerations that the internal rotators are more powerful than the external, that some patients can still invert the limb after a fracture, and that eversion persists during anesthesia.[1] In some unusual cases *inversion* attends the fracture. Inversion, if it exists, is due to the fact that the limb was adducted and inverted at the time of the accident, and after the accident it remains in this position (Stokes). Besides shortening and eversion, the leg is somewhat flexed on the thigh and the thigh on the pelvis, the extremity when rolled out resting upon its outer surface. Abduction is commonly present.

Loss of power is a prominent symptom: the limb can rarely be raised or inverted; although in rare cases, when the fibrous synovial envelope is untorn, the patient may stand or even take steps. Pain is not commonly severe except upon motion, when it may be localized in the joint. In some cases the pain is violent. Crepitus often cannot be found, either because the fragments cannot be approximated, because penetration exists, or because they are greatly softened by fatty change. To obtain crepitus the front of the joint must be examined while the limb is extended and rotated inward. But why try to obtain crepitus? The diagnosis is readily made without it; in many cases it cannot be detected, and the endeavor to obtain it inflicts pain and may produce damage. These fractures offer a not very flattering chance of repair, and efforts to find crepitus may produce serious damage.

Altered Arc of Rotation of the Great Trochanter (Desault's sign).—The pivot on which the great trochanter revolves is no longer the acetabulum, and the great trochanter no longer describes the segment of a circle, but rotates only as the apex of the femur, which rotates around its own axis. It is needless to try to obtain this sign; to do so inflicts violence on the parts.

Relaxation of the fascia lata (Allis's sign) simply means *shortening*. The fascia lata is attached to the ilium and the

[1] Edmund Owen: *A Manual of Anatomy.*

tibia (iliotibial band), and when shortening brings the tibia nearer to the ilium this band relaxes and permits one to push more deeply inward on the injured side, between the great trochanter and the iliac crest, and near the knee above the outer condyle, than on the sound side. In this examination each limb should be adducted. Allis has pointed out another sign: when the patient is recumbent the sound thigh cannot be raised to the perpendicular without flexing the leg; the injured thigh can be. Lagoria's sign is a relaxation of the extensor muscles.

Ascent of the Great Trochanter above Nélaton's Line.—This line is taken from the anterior superior iliac spine to the most prominent part of the ischial tuberosity (Fig. 140). In health the great trochanter is below, and in intracapsular fracture it is above, this line.

Relation of the Trochanter to Bryant's Triangle (Fig. 140).—Place the patient recumbent, carry a line around the body on a level with the anterior superior iliac spines, draw a line from the anterior iliac spine on each side to the summit of the corresponding great trochanter, and measure the base of the triangle from the great trochanter to the perpendicular line to determine the amount of ascent. The difference in measurement between the two sides shows the amount of ascent of the trochanter; that is, shows the extent of shortening.

Morris's measurement shows the extent of inward displacement. Measure from the median line of the body to a perpendicular line drawn through the trochanter on each side of the body.

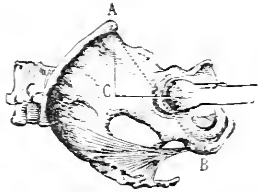


FIG. 140.—A C D, Bryant's ilio-femoral triangle; A B, Nélaton's line (Owen).

Diagnosis.—Intracapsular fracture without separation of the fragments may be mistaken for a mere contusion, and the diagnosis may continue obscure unless the fragments separate. Loss of function in contusion is rarely complete or prolonged although occasionally the head of the bone is absorbed. Early after a contusion, and usually throughout the case, there is no alteration between the relation of the spine of the ilium and the trochanter, and no shortening. Some little time after a severe contusion the head of the bone may be absorbed. Contusion of a rheumatic joint leads to much difficulty in diagnosis. Intracapsular fracture may be confused with *extracapsular* fracture or with a dislocation of the

hip-joint. Extracapsular fracture, which is common in advanced life, but is met with in middle life or even occasionally in the young, results usually from great violence over the great trochanter; if non-impacted, there are noted shortening of from one and a half to three inches, crepitus over the great trochanter, and usually, but not invariably, eversion; if impacted, there is less eversion, crepitus is almost or entirely absent, and the shortening is limited to about an inch. Great tenderness exists over the great trochanter in both impacted and non-impacted fractures. The extensor muscles are relaxed. In dislocation on the dorsum of the ilium the patient is usually a strong young adult. There is a history of forcible internal rotation. There are inversion (the ball of the great toe resting on the instep of the sound foot), rigidity, ascent of the bone above Nélaton's line, and shortening of from one to three inches. The head of the bone is felt on the dorsum of the ilium, and the trochanter mounts up toward the spine of the ilium, and pressure upon it causes no pain. In dislocation into the thyroid notch there is possibly eversion, but it is linked with lengthening.

In *fracture of the brim of the acetabulum* there is shortening, which occurs on the removal of extension, inversion, retained power of everting the limb, abduction, retained power of adduction, flexion of the knee, and the head of bone is drawn upward and backward with the acetabular fragment (Stokes). Crepitus is most distinctly appreciated by a hand resting on the ilium. In fracture of the fundus of the acetabulum there is shortening, and the head of the bone enters the pelvis (Stokes).

Prognosis.—The prognosis is not very favorable. Old people not unusually die. Many surgeons have maintained that bony union never occurs, but it certainly does sometimes take place. Stokes holds that bony union is possible in fractures with penetration, and even in fractures without penetration when the fracture is within the periosteum.[1] Non-union is not unusual. Permanent shortening to some degree is inevitable, and the function of the joint is sure to be more or less impaired. It will be found necessary in many cases for the patient to always employ support in walking.

Treatment.—In treating a very feeble person for intracapsular fracture make no attempt to obtain union. Keep the patient in bed for two weeks, give lateral support by sandbags, tie around the ankle a fillet, attach a weight of a few

[1] See the masterly paper of Stokes, before quoted.

pounds to the fillet, and hang the weight over the foot-board of the bed. When pain and tenderness abate, order the patient to get into a reclining-chair, and permit him very soon to get about on crutches. If hypostatic congestion of the lung sets in, if bed-sores appear, if the appetite and digestion utterly fail, or if diarrhea persists, abandon attempts at cure in any case, and get the patient up and take him into the sunshine and fresh air, simply immobilizing the fracture as thoroughly as possible by means of pasteboard splints. In the vast majority of cases, no matter how old the patients, undertake treatment. We may be forced to abandon it, but should at least attempt to obtain a cure. If it is determined to treat the case, combine extension with lateral support by means of sand-bags and the extension apparatus originally devised by Gurdon Buck. The extension should be gentle, never forcible. It is not wise to pull apart a penetration in an old person, but it should always be done in a young or middle-aged person. Place the subject on a firm mattress, and if the patient be a man, shave the leg. Cut a foot-piece out of a cigar-box, perforate it for a cord, wrap it with adhesive plaster as shown in Plate 6, Figs. 15 and 16, run the weight-cord through the opening in the wood, and fasten a piece of adhesive plaster on each side of the leg, from just below the seat of fracture to above the malleolus (Pl. 6, Fig. 14). The plaster is guarded from sticking to the malleoli by having another piece stuck to its under surface opposite each

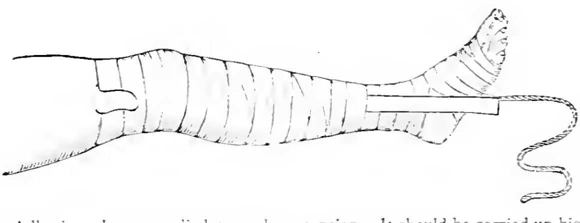


FIG. 141.—Adhesive plaster applied to make extension. It should be carried up higher to a point just below the seat of fracture.

of these points. Apply an ascending spiral reversed bandage over the plaster to the groin (Fig. 141), and finish the bandage by a spica of the groin. Slightly abduct the extremity. Put a brick under each leg of the bed at its foot, thus obtaining counter-extension by the weight of the body. Run a cord over a pulley at the foot of the bed, and obtain extension by the use of weights. From ten to twenty pounds will probably be necessary at first, but after a day or two

from six to eight pounds will be found sufficient (remember that a brick weighs about five pounds). Make a bird's-nest pad of oakum for the heel. Take two canvas bags, one long enough to reach from the crest of the ilium to the malleolus, the other long enough to reach from the perineum to the malleolus. Fill the bags three-quarters full of dry sand, sew up their ends, cover the bags with slips, and put the bags in place in order to correct eversion. The slips may

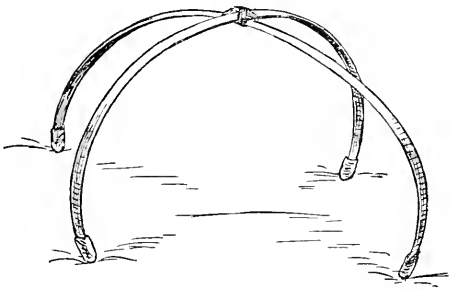


Fig. 142.

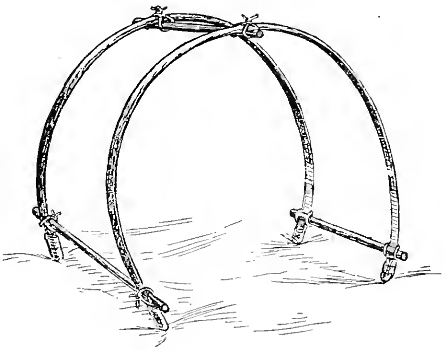


Fig. 143.

Figs. 142, 143.—Cradle to keep clothing from leg, made from two barrel-hoops (Scudder).

be changed every third or fourth day. Keep the bed-clothing from coming in contact with the foot by means of a cradle (Figs. 142, 143). The bowels are to be emptied and the urine is to be voided in a bed-pan, unless using a fracture-bed. Maintain extension for five or six weeks, then mould pasteboard splints upon the part, and keep the patient in bed for three or four weeks more. In from eight to ten weeks after the accident the patient may get about on crutches. Union,

if it takes place, is usually cartilaginous, but is sometimes bony, and there are sure to be some shortening and also some stiffness of the joint. Passive motion is not made until at least eight weeks have elapsed since the accident. Senn claims that by his method of "immediate reduction and permanent fixation" bony union is obtained in fractures of the neck of the femur within the capsule. He "places the patient in the erect position, causing him to stand with his sound leg upon a stool or box about two feet in height; in this position he is supported by a person on each side until the dressing has been applied and the plaster has set.

"Another person takes care of the fractured limb, which in impacted fractures is gently supported and immovably held until permanent fixation has been secured by the dressing. In non-impacted fractures the weight of the fractured limb makes auto-extension, which is often quite sufficient to restore the normal length of the limb; if this is not the case, the person who has charge of the limb makes traction until all shortening has been overcome as far as possible, at the same time holding the limb in position, so that the great toe is on a straight line with the inner margin of the patella and the anterior superior spinous process of the ilium. In applying the plaster-of-Paris bandage over the seat of fracture a fenestrum, corresponding in size to the dimensions of the compress with which the lateral pressure is to be made, is left open over the great trochanter.

"To secure perfect immobility at the seat of fractures, it is not only necessary to include in the dressing the fractured limb and the entire pelvis, but it is absolutely necessary to also include the opposite limb as far as the knee and to extend the dressing as far as the cartilage of the eighth rib.

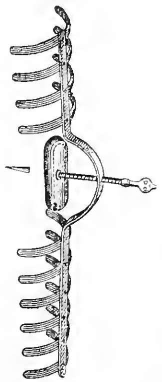


FIG. 144.—Senn's apparatus.

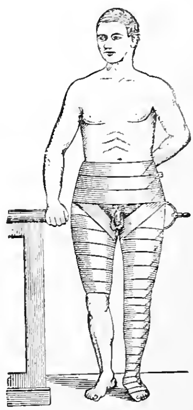


FIG. 145.—Senn's apparatus applied.

"The splint (Fig. 144) is incorporated in the plaster-of-Paris dressing, and it must carefully be applied, so that the compress, composed of a well-cushioned pad with a stiff, unyield-

ing back, rests directly upon the trochanter major, and the pressure, which is made by a set-screw, is directed in the axis of the femoral neck. Lateral pressure is not applied until the plaster has completely set. Syncope should be guarded against by the administration of stimulants.

"As soon as the plaster has sufficiently hardened to retain the limb in proper position, the patient should be laid upon a smooth, even mattress, without pillows under the head, and in non-impacted fractures the foot is held in a straight position and extension is kept up until lateral pressure can be applied.

"No matter how snugly a plaster-of-Paris dressing is applied, as the result of shrinkage it becomes loose, and without some means of making lateral pressure it would become necessary to change it from time to time in order to render it efficient. But by incorporating a splint in the plaster dressing (Fig. 145) this is obviated, and the lateral pressure is regulated, day by day, by moving the screw, the proximal end of which rests on an oval depression in the center of the pad."

Extracapsular Fracture (*Fracture of the Base of the Neck*).—The line of extracapsular fracture is at the junction of the neck with the great trochanter, and is partly within and partly without the capsule, the fracture being generally comminuted and often impacted. The *cause* is violent direct force over the great trochanter (as by falling upon the side of the hip). This fracture is most usual in elderly people, but is not very uncommon in young adults. Stokes has described six forms of extracapsular fracture: extracapsular fracture with partial impaction posterior; fracture with complete impaction; fracture with partial impaction above; fracture with partial impaction below, the shaft being split; splitting of the neck longitudinally without impaction; comminuted non-impacted fracture.[1]

Symptoms.—When impaction is absent there is marked crepitus on motion, which is manifested most distinctly when the fingers are placed upon the great trochanter; there is severe pain, pressure upon the great trochanter is very painful, swelling and ecchymosis are marked; there is absolute inability on the part of the patient to move the limb, and passive movements cause violent pain; there is shortening to the extent of at least one and a half inches, and sometimes to the extent of three inches, which shortening is made manifest by noting the ascent of the trochanter above

[1] *Brit. Med. Jour.*, Oct. 12, 1895.

Nélaton's line, by comparison of the injured limb with the sound limb, and by measuring the base-line of Bryant's triangle on each side. Absolute eversion usually exists with slight flexion both of the leg and the thigh. In some rare cases there is inversion. This happens if at the time of the accident the limb was inverted and adducted (Stokes). Lagoria's sign, Desault's sign, and Allis's sign are present (p. 476). All these symptoms follow violent direct lateral force. In the *impacted* form of extracapsular fracture, in addition to the aid given the surgeon by the history, there is severe pain, which is intensified by movement or pressure; shortening to the extent of one inch at least, which is not corrected by extension; great loss of function; and whereas the limb may be straight or even inverted, it is usually everted. The trochanter is above Nélaton's line, the base-line of Bryant's triangle is shortened, but not so much as in the unimpacted form, there is no crepitus unless the impaction is pulled apart, the arc of rotation of the great trochanter is larger than in a non-impacted fracture, and Allis's sign is noted.

Treatment.—In treating non-impacted extracapsular fracture make extension, raise the foot of the bed, and apply the extension apparatus with sand-bags for four weeks; then apply a plaster dressing. Get the patient up on crutches after the plaster has been in place for two weeks. Remove the plaster at the end of four weeks. In impacted extracapsular fracture it is best to pull apart the impaction if the patient is in good physical condition. Southam of Manchester, in an impressive article, has recently insisted on the absolute necessity of pulling apart an impaction. He gives ether, and when the patient is anesthetized unlocks the fragments.[1] The case is then treated as described above.

Separation of the upper epiphysis of the femoral head is a very rare result of accident; it occurs most often from disease and in youth.

Symptoms and Treatment.—The symptoms are like those of fracture of the neck, except that the crepitus is soft. The *treatment* is extension as above directed.

Fractures of the Great Trochanter.—This process may be (1) broken off without any other injury, but in most cases (2) the line of fracture runs through the trochanter, and leaves one portion of the trochanter attached to the head and neck and the other part attached to the shaft of the

[1] *Lancet*, Dec. 21, 1895.

femur. The *cause* is violent direct force over the great trochanter.

Symptoms and Treatment.—The symptoms of the second form are similar to those of extracapsular fracture. On rotating the femur the lower part of the trochanter moves with it, but not the upper. The lower fragment goes upward and backward and projects by the side of the sciatic notch. There are shortening, eversion, crepitus, and altered position of the trochanter. The symptoms of the first form resemble those of epiphyseal separation. The *treatment* of the second form is like that in extracapsular fracture, and the first form is treated like separation of the epiphysis of the trochanter.

Separation of the epiphysis of the great trochanter is a very rare accident. The *cause* is direct violence, and the injury occurs only in youth.

Symptoms.—The trochanter is found to have ascended and passed posteriorly; there is no shortening of the thigh; all the motions of the hip-joint can be obtained; if the thigh is flexed, abducted, and rotated externally, and the fragment is pushed downward and forward, crepitus is obtained—soft in epiphyseal separation, hard in fracture.

Treatment.—In treating separation of the epiphysis of the great trochanter flex the leg on the thigh and the thigh on the pelvis, place the extremity upon its outer surface, keep it fixed by some form of retentive apparatus, and try to draw the trochanter downward and forward by adhesive strips or by a pad and bandage. Some degree of lameness is inevitable, even after Bryant's extension. Bryant's extension directly upward may admit of the trochanter being pulled into place upon the bone (Fig. 150). Extension must be applied for six weeks, and crutches and pasteboard splints should be used for four weeks more.

2. **Fractures of the shaft of the femur** may affect any portion of the shaft, but especially the middle third, and may occur at any age. Fracture of the upper third is a rare accident. Allis estimates that each year in Philadelphia there is 1 case to every 100,000 inhabitants. Separation of the lower epiphysis occasionally occurs. The *cause* of fractures in the upper third is usually indirect force; fractures in the lower third are due to direct force; and in fractures of the middle third these two causes are about equally potential. Fracture from muscular action occasionally occurs. Oblique fracture is the usual variety.

Symptoms.—The chief symptom in fracture of the shaft

of the femur is great displacement, except when impaction occurs, when the break is due to direct force, or when the injury is in a child. In a child the line of fracture is often transverse and the periosteum may be untorn, and green-stick fractures occur in children. As a rule, in fracture of the shaft of the femur the lower fragment is drawn upward and the upper end of the lower fragment is found posterior and somewhat to the inside of the lower end of the upper fragment, and the lower fragment also undergoes external rotation (the drawing up is due to the rectus and hamstrings; the passing inward is due to the adductor muscles; the rotation outward arises from the weight of the limb). If a fracture of the lower two-thirds of the shaft is produced by direct force, there is usually but little deformity, because the line of fracture is nearly transverse. If produced by indirect force, there is often great deformity, the line of fracture being oblique. In fracture of the lower third of the shaft the gastrocnemius pulls upon the condyles and tilts the lower fragment, so that its upper end projects into the popliteal space and may damage the vessels. In fracture of the upper third the upper fragment is apt to be thrown strongly forward and outward. Some attribute this to the action of the psoas, iliacus, and external rotator muscles, but Allis thinks it is due chiefly to the lower fragment pushing the upper fragment into this position, a part of the tendon of the gluteus maximus acting as a hinge for the fragments.[1] In rare cases the angular deformity is backward. In fracture of the shaft of the femur there is complete loss of function, the thigh and leg being semiflexed and everted. There are shortening to the extent of two or three inches, pain on movement, preternatural mobility, crepitus, and obvious deformity, and the ends of the fragments can be felt by the surgeon. In impaction there is alteration of the axis of the limb and some shortening.

Treatment.—In fracture of the shaft of the femur, if impaction exists, the fragments must be pulled apart, when the case should be treated exactly as is a non-impacted fracture. After a fracture of the shaft of the femur some amount of permanent shortening is almost inevitable. In fracture of the upper third treatment is usually unsatisfactory, and there is permanent shortening from angular union or from overlapping. Horizontal extension fails to correct the displacement of the upper fragment in fracture

[1] "Fracture in the Upper Third of the Femur Exclusive of the Neck," by Oscar H. Allis, *Medical News*, Nov. 21, 1891.

of the upper third. The double inclined plane will not correct the tilting of the upper fragment while shortening exists. Agnew used a double inclined plane and corrected shortening by the use of extension in the axis of the partly-flexed thigh (Fig. 146). This plan is the most ser-

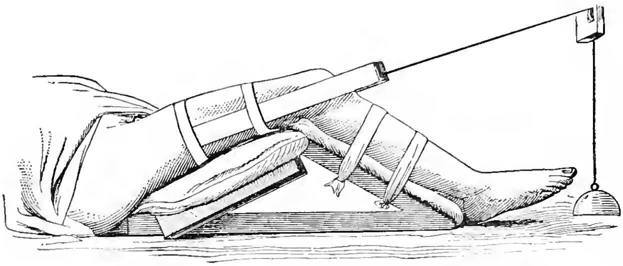


FIG. 146.—Dressing of fracture of the femur in the upper third with extension upon a double inclined plane (Agnew).

viceable of those usually employed, but it too fails to completely correct the displacement. If, notwithstanding position and extension, the upper fragment projects, it should be pushed into place and be retained if possible by short splints bound upon the thigh. Extension should be continued for four weeks, a plaster-of-Paris bandage being used for four weeks more, the patient being then allowed to go about on crutches. Some surgeons, in fracture of the upper third, apply a plaster-of-Paris bandage to the leg, thigh, and pelvis, extension being made from the foot while the dressing is being applied. This method does not give good results because such extension will not correct the tilting of the upper fragment. The anterior splint of Nathan R. Smith is used by some in treating fractures of the upper third of the femur (Fig. 147). It is bent to the desired shape, fastened to the anterior surfaces of the leg and thigh, and hung to a gallows, the limb being suspended at the desired height. This splint is open to the same objection as the

FIG. 147.—Smith's anterior splint.

double inclined plane. Some surgeons use Hodgen's apparatus, but it is not satisfactory. In fact, in fractures of the upper third of the shaft of the femur no apparatus will maintain reduction. In such cases it is advisable to incise, separate the muscle from between the fragments, and fasten

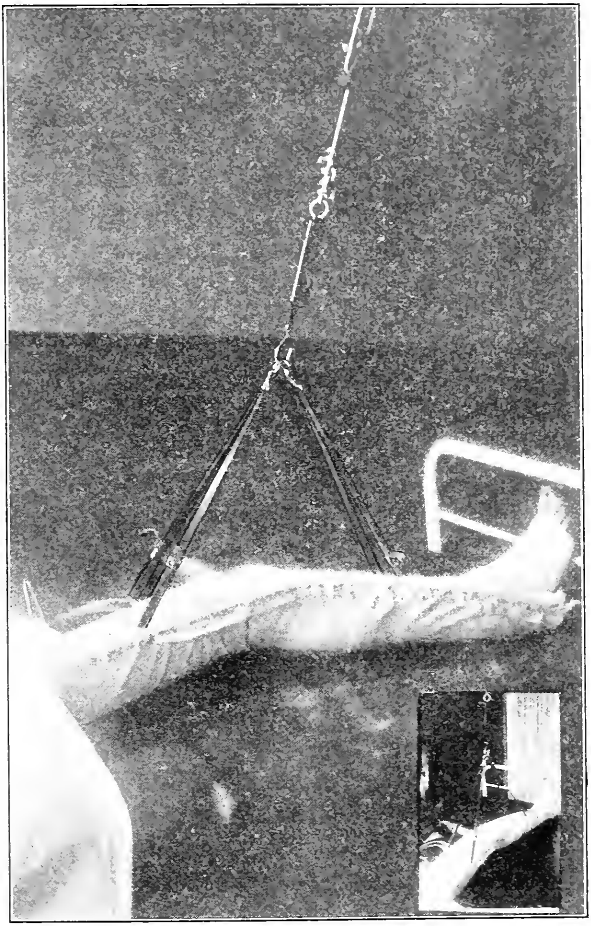


Fig. 148.—Hodgen's apparatus as applied by Dr. George S. Brown.

the ends together with bone ferrules, silver wire, kangaroo-tendon, steel screws, steel pins, or a bone-clamp. This radical treatment has certain dangers of its own but it is the only plan which promises to secure a thoroughly good limb. In fracture of the middle third or upper part of the lower third

of the shaft of the femur, the extension apparatus and sand-bags will usually secure a satisfactory result (Pl. 6, Fig. 14). The strips of adhesive plaster are carried to just below the seat of fracture, and the turns of the roller bandage should be taken to a little above this point. Extension should be continued for four weeks, when the plaster-of-Paris bandage ought to be applied. The plaster is kept in place for four weeks. Many surgeons use Hodgen's splint in treating fractures of the thigh. The limb is suspended in a cradle and extension is obtained by strapping the foot to the cross-bar of the frame and pulling upon the frame by cords (Fig. 148). In fracture of the middle third or upper part of the lower third of the shaft if the line of fracture is transverse and there is little deformity, as is seen often after a fracture by direct force, and often in children, immobilization in an immovable dressing may be all that is required; but if shortening exists, extension must be used. If extension is used, continue it for four weeks and then substitute a plaster-of-Paris dressing

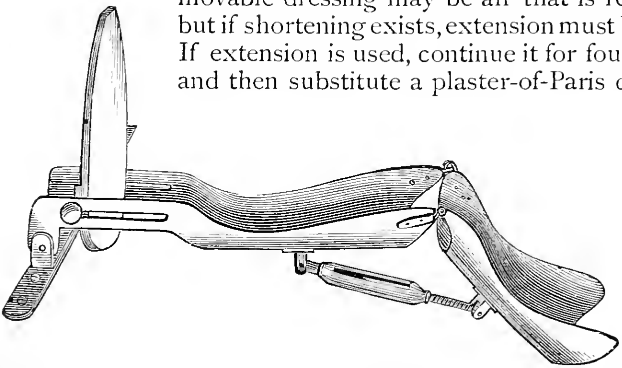


Fig. 149.—McIntyre's splint.

for four weeks. The amount of weight required is pointed out by Dawbarn: one pound for each year up to twenty.[1] In fracture near the knee-joint it may be impossible to effect reduction by horizontal traction. In such a case make traction, and while it is being made gradually bring the leg to a right angle. Place the limb in a double inclined plane (Pl. 6, Fig. 2). A McIntyre splint (Fig. 149) is a useful form of double inclined plane. After four weeks of the use of a double inclined plane apply a plaster-of-Paris dressing, which is to be worn for four weeks.

Fractures of the Thigh in Children.—In children under three years of age the extension apparatus will not satisfactorily immobilize the fragments. Fractures of the thigh in

[1] *Annals of Surgery*, Oct., 1897.

children are reduced by extension and counter-extension; a well-padded splint reaching from the axilla to below the sole of the foot is applied to the outer side of the limb and body. This splint is held in place by bandages which are overlaid with plaster-of-Paris. It is worn for four weeks, at which time it is removed and a plaster bandage, applied so as to include the entire limb, is worn for four weeks more.

Bryant's extension is very satisfactory in treating a child (Fig. 150). Both the injured limb and the sound limb should be flexed to a right angle with the pelvis, fixed by light splints, and fastened to a bar above the bed. The weight of the body produces counter-extension and the child can be easily cleaned.[1]

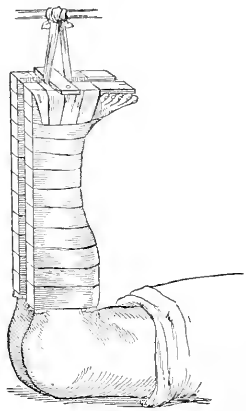


FIG. 150.—Bryant's extension for fracture of the thigh in a child.

Another plan is that of Theodore Dunham.[2] The child is placed upon a table, and the knee and thigh are partly flexed. After first applying flannel rollers, plaster-of-Paris bandages are applied from the roots of the toes to the spine of the tibia, and as a spica about the upper part of the thigh and pelvis. Two pieces of iron, suitably bent, are used to anchor the two plaster bandages together. One end of one iron is attached to the plaster over the groin and one end of the other iron is attached to the plaster over the front of the leg. The free ends of the irons overlap. At the points over the joint and the front of the leg where the irons are to rest masses of plaster are placed. The iron is sunk into the plaster and supported at each spot by several turns of a plaster bandage. While the irons are being adjusted the thigh is so held as to prevent bending or rotation, and the hip and knee are semiflexed. When the plaster has set, an assistant makes extension on the leg and another assistant makes counter-extension by pressing on the pelvis. Any shortening is thus reduced and the two irons are lashed together with strong cord (Fig. 151).

Van Arsdale's triangular splint is a very useful appliance. It is made of binders' board. A. Ernest Gallant[3] describes

[1] Bryant's *Practice of Surgery*.
[2] *Phila. Med. Jour.*, April 23, 1898.
[3] *Jour. Amer. Med. Assoc.*, Dec. 18, 1897.

its preparation and application as follows: Measure the length of the sound thigh from the middle of the groin to the end of the femur. Draw upon cardboard an outline of a double spade (playing-card spade), Fig. 152. Each of the four sections (*A*, *B*, *C*, *D*) must be equal to the length of the child's thigh, the flanged portions being equal to the widest part of the thigh. The figure is then cut out. The cardboard is moistened on one side and folded on the dotted line, section *A* being lapped over *D*, so as to form a triangle. It is fastened together by adhesive plaster. The thigh is flexed and the triangle is applied so that one flanged portion embraces the thigh and the other flanged portion rests on the abdomen The triangle is fixed in position by bandages, figure-of-8 turns being made around the knee and around the thigh and body. Plaster or starch bandages are then applied to fix the splint firmly. The leg should be bandaged from the toe to the knee to prevent swelling (Fig. 153). This splint is worn for three weeks. A child wearing this splint can sit on a chair, nurse, play on the floor and crawl about, may sleep on either side, and the dressing is not soiled by the evacuations.

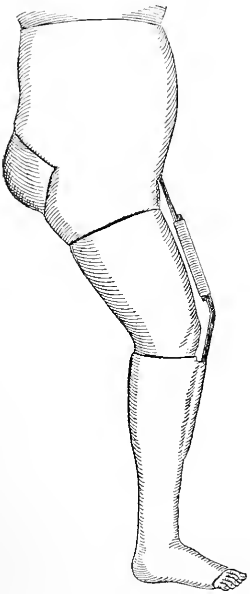


FIG. 151.—Dunham's apparatus for treating fractures of the thigh in infants and children.

If a thigh is fractured during parturition, or during the first few weeks of life, Wyeth's dressing is very serviceable. It is applied as follows: The leg is flexed on the thigh and the thigh on the abdomen. A flannel bandage is applied so as to include the leg, the thigh, and the body from the axilla to the pelvis. Plaster of Paris is applied over this; the dressing is worn for four weeks.

Fractures Just Above the Condyles of the Femur.—The *line* of fracture above the condyles is well above the epiphyseal line. The femoral artery is in danger from the fragments. The *cause* of the break, as a rule, is direct violence. Indirect force is sometimes responsible (falls upon the feet). The knee-joint may be opened. The fracture is sometimes compound.

Symptoms.—The upper end of the lower fragment is

drawn upward and backward, because of the action of the rectus, hamstrings, gastrocnemius, and popliteus. The upper fragment passes inward, and the deformity is very manifest. There are shortening, crepitus, and mobility. The ends of the fragments can be felt by the surgeon. If the force has been very great, a T-fracture results. In T-fracture the knee

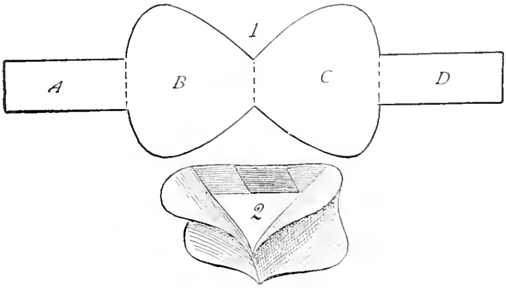


FIG. 152.—1. Diagram showing outline of Van Arsdale's splint. The end band to be folded on the dotted lines; each section to equal the length of the child's thigh. 2. Diagram, splint folded, fastened by rubber plaster, flanges bent to embrace the thigh and abdomen, ready for adjustment (Gallant).

is broadened and crepitus is obtained by moving the condyles, one up and the other down.

Treatment.—In treating fracture above the condyles, reduce the deformity by horizontal extension. If this fails, make traction at the same time, gradually bringing the leg to a right angle with the thigh. Place the limb on a double inclined plane for five weeks, then begin passive motion once every

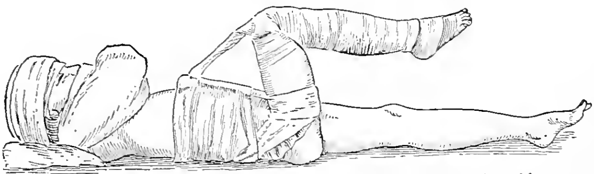


FIG. 153.—Showing Van Arsdale's triangular splint in position. Note the wide space between the dressings and the excretory passages (Gallant).

other day, restoring the limb to the splint after the movements are completed. At the end of eight weeks after the accident remove the dressings, and, if the knee-joint be stiff, use for some time massage, motions, hot and cold douches, ichthyol inunctions, etc. Bryant treats this fracture in extension, cutting the tendo Achillis, if necessary, to amend deformity. It is occasionally necessary to wire the fragments. Some cases

demand amputation because of injury to the structures in the popliteal space.

Fracture Separating Either Condyle.—The *cause* of this fracture is direct force.

Symptoms and Treatment.—The broken piece is drawn upward, the leg bends toward the injury, crepitus exists, the knee is much broadened, there is no shortening, and considerable swelling is sure to arise. In treating a fracture separating either condyle, use a double inclined plane as directed above.

Longitudinal fractures run upward from the knee-joint. The *cause* is a fall upon the feet or the knees.

Symptoms and Treatment.—The symptoms of longitudinal fracture are often obscure. The femur is broadened when the knee is flexed. The split may be detected between the condyles. The *treatment* is the straight position in plaster for eight weeks.

Separation of the lower epiphysis occurs only before the twenty-first year. It is not a very rare accident in children.

Symptoms.—The symptoms in separation of the lower epiphysis are like those of transverse fracture, but crepitus is moist. The lower fragment is tilted, so that the articular surface looks forward. The lower end of the upper fragment projects into the popliteal space. The danger is that the growth of bone will be stunted.

Treatment.—Reduction may be effected in some cases by horizontal extension. Occasionally this is impossible.[1] In such a case adopt the plan of Hutchinson and Barnard, make extension, and while it is being made gradually place the leg at a right angle to the thigh. This is effected by an assistant making traction on the leg, while the surgeon clasps his hands beneath the lower part of the thigh and draws upward. The treatment for separation of the lower epiphysis is the use of a double inclined plane as above directed.

Fracture of the patella is a very common accident. The *cause* is direct force (producing vertical, star-shaped, or oblique lines of fracture) or muscular action (producing a transverse line of fracture).

Fractures of the Patella by Muscular Action.—The knee-cap is more often broken by muscular action than is any other bone. When the knee is partly flexed the middle third of the patella rests upon the condyles of the femur and the upper third of the knee-cap projects above them; when

[1] See the case reported by Jonathan Hutchinson, Jr., and Harold L. Barnard, *Lancet*, May 13, 1899.

in this position a contraction of the quadriceps may easily cause a fracture near the center of the bone (Fig. 154). The accident may be caused by sudden flexion of the knee when the quadriceps is contracting. The most usual cause is a fall or an attempt of the patient to save himself from a fall. Both patellæ may be broken at once. In fracture of the patella the joint, and often the prepatellar bursa, is opened. Fractures by muscular action are transverse. The injury is more common in males than in females, and is extremely rare in the very young and the old. It is an injury of active manhood and middle life.

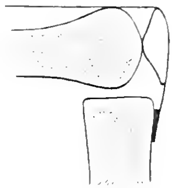


Fig. 154.—Mechanism of fracture of the patella by muscular action (after Treves).

Fig. 155.—Fracture of the patella (Pennsylvania Hospital case; skiagraphed by Dr. Gaston Torrance)

Symptoms.—When the accident happens there is often an audible crack. As a rule, the patient will not try to use the

limb, although it is possible for him to stand, to walk backward, and to move slowly forward when the extremity is kept straight. After the accident there is rapid and enormous swelling, due to the effusion first of blood and then of synovia and inflammatory products into and around the joint. The patient is absolutely unable to raise the limb from the bed. The fragments are movable and usually widely separated (Fig. 155), this separation being distinctly manifest to the touch unless

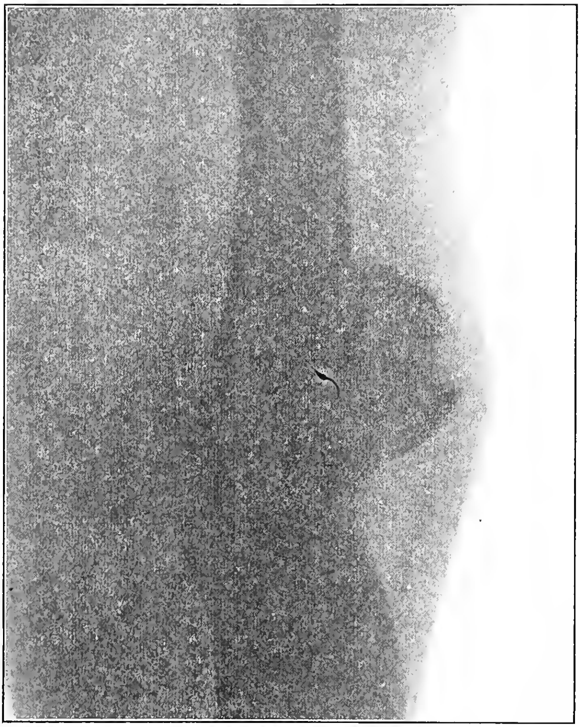


Fig. 156.—Fracture of the patella (Pennsylvania Hospital case; skiagraphed by Dr. Gaston Torrance).

swelling is great. The separation is accentuated by flexion of the leg. The separation may be to the extent of one inch or even more. In cases in which the lateral fibrous expansions and periosteum are but slightly torn, there may be slight separation or no separation. Separation is due in part "to the retraction of the quadriceps and the tension of the fascia lata, and in part to distention of the joint by blood and exudate."[1]

[1] Stimson's *Treatise on Fractures and Dislocations.*

If fragments are not approximated and union does not occur, the separation becomes gradually greater because of the progressive shortening of the muscle and the retraction of the ligamentum patellæ (Stimson). In some cases an anterior angular displacement occurs because of the intra-articular distention (Fig. 156). It may be produced by the pressure of bandages or strips of plaster when the fragments have been brought together. Crepitus is detected if the upper fragment can be pushed down until it touches the lower piece; but if swelling is great, or if fibrous tissue is interposed between the bones, crepitus cannot be elicited. It is useless to seek for it, as the diagnosis is obvious without this sign. The anterior fibroperiosteal layer is torn, and the tear does not correspond exactly with the line of fracture. A portion of this torn fibroperiosteal layer may, as Macewen pointed out, pass between the fragments and prevent union (Fig. 157). The lateral expansions of the capsule are usually extensively torn. Union, if it occurs, will probably be ligamentous, and if the patient gets about too soon, even apparently well-united fragments will by degrees stretch far asunder.

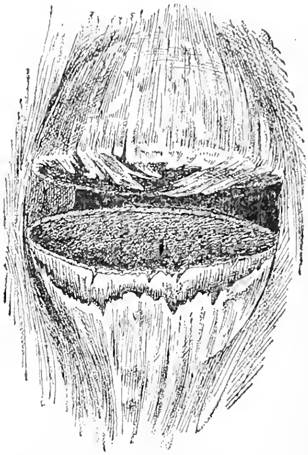


FIG. 157.—Transverse fracture of the patella; fractured surface partially covered by irregular flaps of torn aponeurosis (Hoffa).

Treatment of Transverse Fractures of the Patella.—If in transverse fracture of the patella the swelling is so great as to prevent approximation of the fragments, reduce it by bandaging for a day or two, by using ice-bags, or by aspirating the joint. As a rule, the blood does not coagulate for several days. After it coagulates it cannot be withdrawn by aspiration, but only by incision. When the swelling diminishes, bring the two fragments into apposition, pull them together by adhesive plaster, and put on a well-padded posterior splint. Carry a piece of adhesive plaster over the upper end of the upper fragment, draw the bone down and fasten the plaster behind and below the joint. Carry another piece of plaster over the lower end of the lower fragment, draw the bone up, and fasten the plaster behind and above the joint.

Carry a third piece over the junction of the fragments to prevent tilting. Agnew's splint admirably accomplishes this approximation (Pl. 6, Figs. 11, 12). A bandage holds the splint in place, and may be carried around the knee by figure-of-8 turns. The heel is sometimes raised upon a pillow so as to extend the leg and to semiflex the thigh, but this is not essential. Remove and reapply the dressing every few days, as it inevitably becomes loose. At the end of three weeks remove the splint permanently and apply a plaster-of-Paris dressing from just above the ankle to the middle of the thigh, and get the patient about on crutches. The dressing is to be worn for five weeks. After eight weeks of treatment allow the patient to walk with canes, the joint being kept fixed for four weeks more by pasteboard splints or by a light plaster-of-Paris bandage. For one year after removing the splints and plaster a lacing knee-cap of leather should be worn in the daytime to support the joint. The plan of prolonged immobilization renders more or less joint-stiffness a certain occurrence, but this is less of an impediment than the wide separation of the fragments that inevitably attends an early use of the joint. Bryant of New York has devised an ambulatory dressing.

Malgaigne's hooks are practically obsolete.

It is said that John Rhea Barton wired an ununited fracture of the patella in 1843. In 1877 Hector Cameron wired an ununited fracture of the patella, and a few months later Lord Lister operated on a fracture of the knee-cap two weeks after the accident. The question of the advisability of suturing a recent fracture is very much disputed. The ordinary non-operative plans of treatment do not endanger life and usually give a good functional result. The operative method will usually succeed, and is capable of obtaining a better functional result and of obtaining it more rapidly. There is some danger of infection, and if infection should occur the results will be most disastrous. Some cases obviously cannot be treated by the ordinary method with any chance of success; cases, for instance, in which a flap of fibroperiosteum intervenes between the fragments, or cases in which from some other cause the bones cannot be approximated. Such cases should, of course, be operated upon. But in the great majority of cases a good result will follow conservative treatment, and conservative treatment should be trusted to unless the case is in the hands of a surgeon and in a place where every antiseptic precaution can be taken. We agree with Stimson when he says that operative methods can be

used with confidence when surrounded with every protection; he habitually uses them, but he never teaches them as proper routine practice, and strongly advises against their use except by those who have had experience in operating,

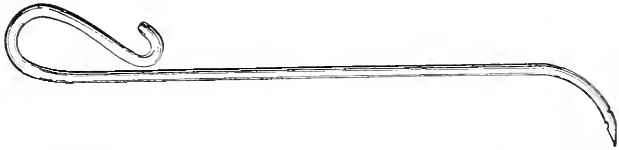


FIG. 158.—Needle specially designed to carry a thick wire. The eye is drilled obliquely, and should receive only a little loop on the end of the wire; this loop should be made previously.

who have formed the habit of taking precautions, and who have the aid of skilled assistants.[1] Operation should only be performed on healthy persons of suitable age, when the separa-

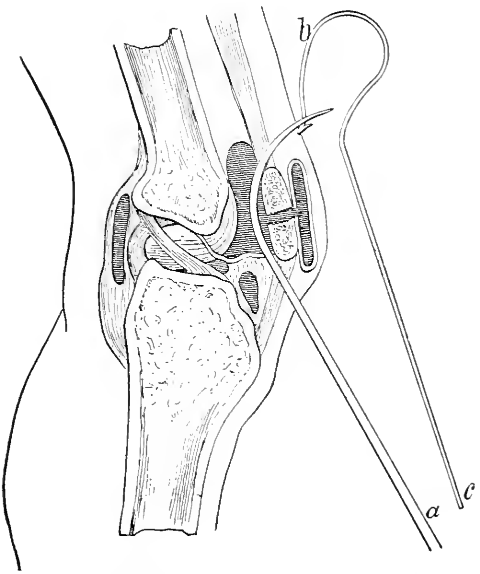


FIG. 159.—Needle (*a*) introduced behind the fragments, and receiving one end (*b*) of the silver wire (*b*, *c*) (Barker).

tion is over one-half an inch or when there is much laceration of the capsule.[2] Barker believes strongly in wiring recent transverse fractures. He does it with antiseptic care soon after

[1] *Annals of Surgery*, August, 1898.
[2] Powers, in *Annals of Surgery*, July, 1898.

the accident, and permits passive motion or even slight active motion immediately after the operation. Massage is begun the day after the operation, and is practised daily for two weeks.

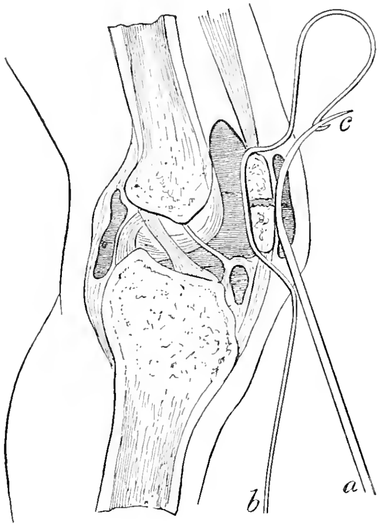


Fig. 160.—Needle (*a*) passed in front of the fragments and receiving the other end (*c*) of the silver wire (*b, c*) (Barker).

Barker[1] uses a special needle (Fig. 158) and silver wire of the thickness of a No. 1 English catheter. This wire is straightened and softened in a spirit-flame. He rubs the fragments together in order to dislodge blood or fibrous material, and when marked grating occurs he introduces the wire. A puncture with a small knife is made through the middle of the upper attachment of the patellar ligament. The needle, not carrying any wire, is made to enter through this opening into the joint, is passed back of the fragments, pierces the tendon of the quadriceps at the upper edge of the upper fragment, and its point is cut upon with a knife. The wire is inserted into the eye of the needle and the needle is withdrawn and unthreaded. The empty needle is pushed through the lower opening, is carried in front of the joint, is made to emerge at the upper opening, is threaded again and withdrawn (Figs. 159, 160). The wires are threaded into bars and twisted (Fig. 161). There are objections to Barker's operation: It does not allow us to remove blood-clots from the joint; if a bit of tissue intervenes between the fragments, it cannot be removed; and a foreign body is left permanently in the joint.[2] If an operation is thought advisable, we deem it best to do an open operation, making a central incision, freeing the joint from blood-clots by irrigation with hot salt solution, removing all tissue from between the fragments, drilling the fragments, passing silver wire, twisting the wire and drawing the fragments together, and closing the wound (Fig. 162).

[1] See the objections of Sir William Stokes to Barker's method, in *Brit. Med. Jour.*, Dec. 3, 1898.
[2] *Brit. Med. Jour.*, April 11, 1896.

Instead of wire, silk may be used. In cases in which there is no very strong tendency to separation the fragments can be held together by several catgut sutures through the periosteum at the fractured edges or by a strong catgut suture passed through the ligamentum patellæ and the quadriceps tendon and carried in front of the fracture (Stimson). The limb should be placed on a posterior splint. In seven or eight days the superficial sutures are removed and a plaster-of-Paris splint is applied. In a few days the patient gets about on crutches. In a month the dressing is cut down the front and worn only in the day-time, and passive motion is begun. The splint is discarded at the end of the third month.[1]

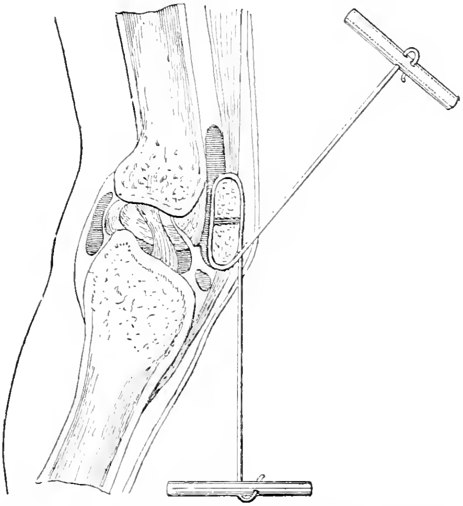


FIG. 161.—Wire in position round fragments and threaded through metal bars. The lower and posterior wire runs upward to the left of the upper, ready for twisting (Barker).

Among other operative procedures we may mention the following: Encircling the fragments with a silk suture (the circumferential suture). This suture may impair bone nutrition and retard union. Ceci drills the bones subcutaneously and passes wire through the drill-holes in the form of a figure-of-8. Passing subcutaneously a ligature around and over the fragments (Butcher). Incision and approximation of the fragments by fixation-hooks or metal pins.

Fractures of the patella by direct force are vertical, stellate, oblique, or V-shaped, are often incomplete and occasionally compound or comminuted.

[1] Stimson, *Annals of Surgery*, August, 1898.

Symptoms.—Fractures of the patella by direct force are followed by discoloration, swelling, great difficulty in movement, and much pain. There may or may not be crepitus. The degree of separation of the fragments depends upon the

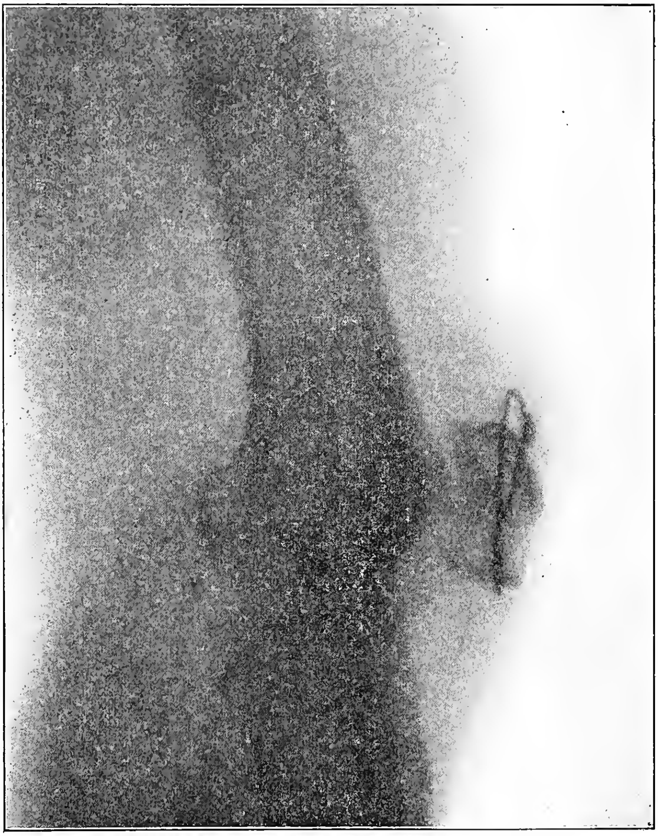


FIG. 162.—Wired fracture of the patella (St. Joseph's Hospital case; operated upon and skiagraphed by Dr. Nassau).

direction of the line of fracture, and the extent of bone involved. Bony union is apt to occur after such a fracture.

Treatment.—A fracture resulting from direct force may often be treated with a posterior splint and the application of a bandage. If there is any separation, the fragments should be approximated by adhesive strips, bandages, and compresses. At the end of three weeks remove the posterior splint, ap-

ply a plaster-of-Paris splint, and get the patient about on crutches. The danger in these cases is ankylosis rather than non-union; hence, in the fourth week, cut the plaster splint down the front and begin passive motion of the knee-joint. At the end of six weeks cease wearing the dressing in the daytime, and at the end of three months discard it entirely. In those rather unusual cases, in which an oblique fracture with wide separation arises from direct force, treat as advised for transverse fracture from muscular action. The question of operation is practically the same as for transverse fracture from muscular action. In every compound fracture of the patella, if amputation can be avoided, incise, irrigate the joint with hot saline fluid, suture the fragments, and drain for twenty-four to forty-eight hours.

Ununited and Badly United Fracture of the Patella.—There is usually a band of union, but it may be very thin and the fragments may be far asunder. It is usually taught that the degree of functional impairment depends directly on the amount of separation. This is not strictly true. There may be great separation, and but little impairment of function, the fragments being firmly united with a dense fibrous band. There may be little separation and yet lameness, stiffness of the joint, and imperfect power of extension. The reason of this has been pointed out by Bruns of Tubingen.[1] He says there may be complete failure of union, even when the separation is trivial, and failure of union produces impaired function. If separation is considerable, the fragments are apt to tilt and tissue is often interposed between them. Functional difficulty is more often met with when the fragments are far apart than when they are near together, because non-union is more common. Even if non-union occurs, in some cases the quadriceps is still able to act upon the tibia by means of the fascia lata, ligaments at the sides of the joint, or bands from the vasti to the lower fragment. Besides non-union, functional impairment may be due to anchoring of the upper fragment to the femur. The upper fragment is anchored to the femur by the interposition of the fibrous investment of the knee-cap, which covers the fractured surface of the upper fragment and grows fast to the capsule of the joint (Bruns).

The *treatment* of ununited and badly united fracture is discussed on page 496.

[1] *Beiträge zur klinischen Chirurgie Mittheilungen aus der Chirurg. Klinik zur Tubingen*, Bd. 3, Heft 2, 1888.

Fractures of the Leg.—In leg-fractures both bones or only one bone may be broken.

Fractures of the tibia are divided into (1) fractures of the upper end; (2) separation of the upper epiphysis; (3) fractures of the shaft; (4) fractures of the lower end; and (5) separation of the lower epiphysis.

Fractures of the upper end of the tibia are uncommon. They may be transverse, oblique, or vertical, running into the joint. The *cause* is direct violence.

Symptoms.—In fracture of the upper end of the tibia there is contusion of the soft parts. In a *transverse* fracture there are mobility and crepitus, but there is little displacement. In *oblique* fracture crepitus and mobility are marked, the axis of the limb is altered, and the fragment may be displaced. In fractures entering the joint there is great swelling of the knee-joint. In *comminuted* fractures, which exhibit marked signs, union is readily obtained, but if the joint has been damaged stiffness is sure to ensue.

Treatment.—Reduce displacement by extension and manipulation. The special apparatus used depends on the case. In some cases extension is required, in some a posterior splint is applied and the limb is suspended from a gallows, in some a double inclined plane is employed, and in some a plaster-of-Paris splint is used.

The double inclined plane in the form of McIntyre's splint is frequently employed, or a double inclined plane in the form of a fracture-box may be preferred. The extremity should be immobilized for four weeks, when passive motion should be begun. Passive motion is to be made daily, the dressing being reapplied after each séance. In five or six weeks the dressings are removed and the patient allowed to go about on crutches. The crutches are soon abandoned for a cane, and later all support is dispensed with. If a fracture extends into the knee-joint and the ill-adjusted fragments block the joint, the joint should be opened and the fragments placed in proper position.

Separation of the tubercle of the tibia is due to violent contraction of the quadriceps, and occurs in those under twenty years of age. The fragment is drawn up and can be felt, and the patient is unable to use the limb. In a case in which the tibial spine has been torn off, the limb should be placed on a posterior straight splint and the fragment should be pulled down into place by adhesive strips and bandages. The splint should be worn for five weeks.

Separation of the Upper Epiphysis of the Tibia.—This is an injury of extreme rarity. It does not seem to occur after the sixteenth year. It is caused by a twist or by violent abduction or adduction of the leg. It may lead to lessened growth of the limb. The *treatment* is as for a fracture of the upper end.

Fractures of the Shaft of the Tibia.—The *causes* of these fractures are direct force, indirect force, or torsion. The fracture is generally transverse in the upper part of the bone and oblique in the lower part (Pickering Pick).

Symptoms.—In transverse fracture of the shaft of the tibia there is no deformity, and the support of the fibula may even permit of walking; there is fixed pain; there may or may not be inequality of the fragments felt by the finger; and there are crepitus, mobility, and often linear ecchymosis. In oblique fractures there usually exist crepitus, a little mobility, and distinct deformity. The deformity depends on the direction of the line of fracture, and, as this line is usually from above downward, inward, and a little forward, the lower fragment usually passes behind the upper fragment and rotates inward.

Treatment.—In treating fractures of the shaft of the tibia, effect reduction by making extension from foot and counter-extension from the knee, the knee being in partial flexion. If there be much swelling, put the limb in a fracture-

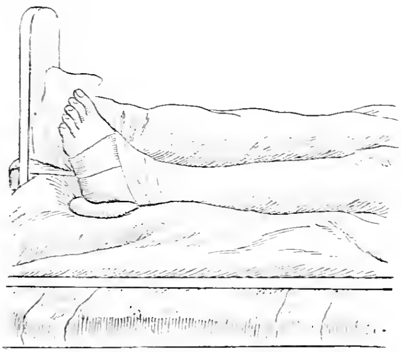


FIG. 163.—Fracture-box in fractures of the bones of the leg.

box (Pl. 6, Fig. 1; Fig. 163), swing the box from a gallows, and apply an ice-bag for a day or two. A silicate-of-sodium or a plaster-of-Paris dressing is applied when the swelling subsides, or the dressing is used at once if swelling is slight. As soon as the limb is immobilized in a silicate or plaster dressing the patient gets about on crutches. The dressing is

removed after five weeks, and the patient goes about for one week on crutches, lightly using the foot, and then for a time with a cane. At the end of eight or nine weeks the cane may often be dispensed with, the amount of use of the leg being daily augmented.

Fractures of the Lower End of the Tibia: Fracture of the Inner Malleolus.—The *cause* of fracture of the inner malleolus is direct force or traction upon the internal lateral ligament.

Symptoms and Treatment.—The *symptoms* of fracture of the inner malleolus are some downward displacement, depression above the fragment, mobility, and crepitus. The *treatment* is to push the fragment into place and use side-splints or a fracture-box for two weeks, when a plaster-of-Paris or a silicate dressing may be substituted and the patient be ordered to use crutches. Remove the plaster four or five weeks after it is applied, and direct the patient to gradually bear his weight upon the leg, as outlined above.

Separation of the lower epiphysis of the tibia is a rare accident, but is commoner than separation of the upper epiphysis. The *treatment* is a fixed dressing for six weeks.

Fracture of the fibula alone is commoner by far than is fracture of the tibia alone. Fractures in the upper two-thirds, which are rare, are usually due to direct force. Fractures in the lower third are frequent, and they arise from indirect force.

Fractures of the Upper Two-thirds of the Fibula.—In these fractures the *cause* is direct force.

Symptoms.—In fracture of the upper two-thirds of the fibula the patient can often walk. The bone is deeply situated, and displacement cannot often be detected. There is a fixed pain, which is intensified by movement and by pressure. Pressure upon the lower fragment does not move the upper fragment. Crepitus is sometimes obtained, and a linear ecchymosis is apt to appear. The bone is normally elastic, hence slight mobility is of no value diagnostically.

Treatment.—In treating a fracture of the upper two-thirds of the fibula apply a plaster-of-Paris or a silicate bandage and direct that it be worn for five weeks. Weight is not to be put upon the foot for six weeks after the accident.

Fractures of the Lower Third of the Fibula.—In these fractures the *cause* is indirect force, especially twists of the foot. Forcible inversion of the foot pulls upon the external lateral ligament and the external malleolus, forces the fibula outward, and tends to break it, the lower fragment being displaced outward. Forcible eversion pulls the internal lateral

ligament off from the inner malleolus (often breaks the malleolus) and fractures the fibula above the ankle, the bone being displaced inward.

Pott's fracture.—By the name Pott's fracture is meant a fracture of the lower fifth of the fibula produced by eversion and abduction of the foot. Stimson points out that the production of Pott's fracture is often aided by the weight of the body. The lesions which arise depend upon whether the chief force is eversion or abduction. "If eversion is the sole, or main, movement, the force is exerted through the internal lateral ligament and breaks the internal malleolus squarely off at its base; then it presses the external malleolus outward, rupturing the tibiofibular ligament, and breaks the fibula close above the malleolus. Sometimes instead of pure rupture of the tibiofibular ligament there is avulsion of the portion of the tibia to which it is attached."[1] Stimson further points out that if abduction is the preponderating force there is an oblique fracture of the anterior portion of the internal malleolus or more frequently rupture of the anterior portion of the internal lateral ligament. There is, as in the former case, rupture of the tibiofibular ligament and an oblique fracture of the fibula several inches above the external malleolus. It is evident that the degree of injury produced by eversion and abduction depends on the time at which the force is arrested. It may be arrested after the inner malleolus has been separated or the anterior fibres of the deltoid ligament torn, and in this case the tibiofibular articulation remains intact and the fibula is not broken. It may cease after separating the tibiofibular articulation, and in this case too the fibula escapes. It may be continued until the fibula breaks. In this fracture the astragalus passes outward, somewhat backward and also upward, the later deviation being due to separation of the tibiofibular articulation.

Symptoms.—The foot is displaced outward, and a little backward and upward, and the inner malleolus or the tibia from which it was torn, is extremely prominent. There is great lateral mobility and often anteroposterior mobility at the ankle-joint. Stimson points out that there are three points where pressure is certain to provoke pain: in front of the tibiofibular ligament, at the base or anterior border of the inner malleolus, and over the seat of fracture through the fibula.

Treatment.—Thorough reduction is of the greatest importance. If thorough reduction is effected, a good result will probably be obtained; but if thorough reduction is not effected the

[1] *A Practical Treatise on Fractures and Dislocations*, by Lewis A. Stimson.

patient will be permanently crippled to a greater or less extent. In order to effect reduction it may be necessary to anesthetize the patient. The deformity is corrected "by pressing the calcaneum forward and inward; the hand is placed against the back and outer side of the heel and pressed forward and then forcibly inward."[1]

Some surgeons at once surround the limb with a plaster-of-Paris bandage. This treatment is objectionable because the deformity may be practically reproduced, the surgeon being unable to see it, and hence unable to correct it. If there seems to be no strong tendency to a recurrence of deformity, a fracture-box can be used.

After reducing displacement, place the limb in a fracture-box containing a soft pillow. A bird's-nest pad of cotton or oakum is made for the heel (Fig. 163). A fillet around the ankle fastens the foot to the foot-piece of the box; a pad of oakum rests between the foot-piece and the sole. A compress is placed below the outer malleolus and another one above the inner malleolus. Close the sides of the box and tie them together with a bandage, and swing the box on a gallows. Every day let down the sides of the box and rub the leg, the ankle, and the foot with alcohol. In ten days apply a plaster-of-Paris bandage and let the patient get about on crutches. Remove the plaster at the end of the fifth week after the accident, and let the patient go about with crutches for one week and with a cane for a week longer.

Some surgeons dress Pott's fracture with a Dupuytren splint. This is a straight splint (Pl. 6, Fig. 9) which reaches from the head of the tibia to or below the toes. This splint is padded, and a pyramidal pad with the base down is laid upon the inner surface of the leg, above the inner malleolus, the splint being put upon the inner surface of the leg, over the pad. The splint is fastened as shown in Plate 6 (Fig. 9), and the leg is semiflexed upon the thigh and is laid upon its outer surface on a pillow. After ten days apply the plaster-of-Paris bandage, which is to be worn as above directed. Bryant treats Pott's fracture with a posterior splint, two lateral splints, and a swing. Stimson uses a posterior and lateral splint of plaster of Paris. This splint does not slip, as may Dupuytren's dressing, and does not hide the seat of fracture from view as does complete encasement with plaster of Paris. It is a most useful dressing. The fracture may be compound, a portion of the inner malleolus or of the tibia projecting through the wound. If it is necessary to introduce through

[1] Stimson's *Practical Treatise on Fractures and Dislocations.*

and through drainage, the foot must be placed and kept at a right angle to the leg. If a compound fracture exists, it may be possible to wire the malleolus in place. In a reported case the wire was passed through the joint and around the fragment, and the result was good.[1] It would be better to nail the fragment in place.

Fracture of both bones of the leg is a very common injury, is often compound, and is not unusually comminuted. Fractures by direct force, such as blows or kicks, are commonest in the upper half of the leg. Fractures by indirect force, as by falls, are commonest in the lower half of the leg. In fractures from indirect force the tibia breaks first, and then the fibula breaks at a higher level. The point of greatest liability to fracture from indirect force is the junction of the lower and middle thirds. Fractures of the leg are usually oblique, but they may be transverse if arising from direct force. Spiral, torsion, or V-shaped fractures and longitudinal breaks sometimes occur. In oblique fractures, as a rule, the line of fracture runs downward, inward, and a little forward.

Symptoms.—Fracture of both bones of the leg is easy of recognition. The fibular fracture is detected as before described. By running the finger along the crest of the tibia displacement will be found, except in transverse fractures, when it may not occur. The common displacement is for the lower fragment to ascend and pass behind the lower end of the upper fragment and to rotate a little outward, and for the upper fragment to project in front. The ascent of the lower fragment is due to the action of the gastrocnemius and soleus muscles. If the line of fracture is in a direction the reverse of that which is usual, the lower fragment ascends in front of the lower end of the upper fragment. In fracture of both bones of the leg there are marked mobility and crepitus, severe pain, and inability to walk. In fractures from direct force there is more or less damage to the soft parts. A fracture of the shaft of the tibia near the ankle is distinguished from a dislocation by the fact that the deformity is easily reduced, but tends to recur in the fracture, and, further, that in a fracture the relations of the malleoli to the tarsus are unaltered, whereas in a dislocation they are altered.

Treatment.—If the fracture is near the ankle-joint, the action of the tendo Achillis may maintain deformity, and in such cases the tendon must be divided. In treating a simple fracture of the lower two-thirds of the bones reduce by ex-

[1] *Rev. de Chir.*, vol. viii., 1888.

tension and counter-extension, and use a fracture-box (Pl. 6, Fig. 1) as in Pott's fracture (p. 506), though the compresses are not required. If the soft parts are bruised, use an ice-bag for a day or two; if they are abraded, apply antiseptic dressings. The fracture-box should be swung upon a gallows. After three weeks apply plaster-of-Paris or silicate-of-sodium dressing and let the patient sit up in a chair daily for one week; at the end of this time the patient may get about with crutches. At the end of six weeks after the accident remove the plaster, and let the sufferer get about on crutches for two weeks and with a cane for two weeks more. Brinton dresses a fracture of both bones of the leg for two weeks in a fracture-box, for two weeks in side-splints made of metal, and for two weeks in an immovable dressing, allowing the patient to get about on crutches as soon as the plaster is put on. Instead of the fracture-box, we may use a posterior splint, two lateral splints, and a swing. Nathan R. Smith's anterior splint is used by some in the treatment of fractures of the leg. Many surgeons apply plaster of Paris in the form of an ambulatory dressing. In this dressing a solid apparatus reaches to the lower third of the thigh and below the sole of the foot. When the patient walks the weight is transmitted to the thigh (Fig. 166). In fractures of the upper third of the leg the McIntyre splint or the double inclined plane is used. If the fracture is compound, asepticize thoroughly, make a counter-opening, insert a drainage-tube, dress with bichlorid gauze, apply a plaster bandage, and cut trap-doors over the openings of the tube (see Fig. 114), or dress with the bracketed splint and plaster of Paris (Fig. 115). Remove the tube, as a rule, in about forty-eight hours; but the patient's temperature is a better guide than time.

Fractures of the bones of the foot are rather rare accidents. Owing to the number of the bones and to the elasticity of their connections, the force of blows and falls is spread and dissipated. Fractures from direct force are often compound. The *cause* of fracture of either the scaphoid, the cuboid, or one of the cuneiform bones is direct force. Fractures of the os calcis and astragalus arise, as a rule, from indirect force, such as falls, but the calcaneum may be broken by direct violence. In rare instances the os calcis has been broken by contraction of the great calf-muscles.

Symptoms.—In fracture of the os calcis there are severe pain, swelling, crepitus, mobility, often an apparent widening

of the bone, not unusually a loss of the arch of the foot (Pick). In some cases the posterior fragment is drawn up by the calf-muscles, and in other cases there is deformity. In fracture of the astragalus displacement may occur which resembles that of a dislocation. Crepitus may or may not be detected. It can be elicited, as a rule, by rotating the foot while the heel is firmly held. If crepitus cannot be detected, it is not certain that a fracture is present, though the patient may be unable to stand and there may be swelling and pain on pressure. Fractures of the other bones are difficult of detection. There may or may not be crepitus, which, if it exists, is hard to localize; there is pain on standing and on pressure, and there is bruising of the soft parts.

Treatment.—To treat a fracture of the os calcis when no deformity exists, use a fracture-box for two weeks, maintaining the foot at a right angle to the leg; then put on an immovable dressing, and let it be worn for four weeks. In fracture of the os calcis with drawing up of the posterior fragment flex the leg upon the thigh, extend the foot, and maintain this position by means of a band around the thigh, the band being fastened by means of a cord to a slipper (Pl. 7, Fig. 5), the leg resting upon its outer side. At the end of two weeks apply plaster of Paris, and let it be worn for four weeks. Many cases require incision and nailing or wiring the fragments together. If the projecting fragment of the os calcis cannot be forced into place, and if it makes dangerous pressure upon the skin, excise it; if it does not make pressure which threatens sloughing, place the joint in a position favorable for ankylosis, and immobilize. In a fracture of the astragalus use a fracture-box and then an immovable dressing, as in fracture of the os calcis without deformity. Fractures of the other bones of the tarsus are almost invariably compound, and the injury may require drainage and immovable dressing, excision of bones, or even amputation.

Fractures of the metatarsal bones are due to direct force and are almost always compound. Fractures from crushes usually demand excision or amputation. When only one bone is broken displacement is slight, there is severe pain on motion and pressure, and crepitus can generally be obtained. A simple fracture of a metatarsal bone is treated by an immovable dressing for four weeks.

Fractures of the phalanges of the toes are due to direct force and are often compound. They may require immediate amputation.

Treatment.—In a compound fracture where amputation is unnecessary, drain with strands of catgut for forty-eight hours and dress antiseptically; at the end of this time apply over the bichlorid gauze a gutta-percha or a pasteboard splint extending from beyond the end of the toe to well up upon the sole of the foot, and fix the splint in place with a spiral bandage of the toe and instep. The splint is to be worn for four weeks. In a simple fracture fasten the injured toe to an adjacent toe or toes by a plaster bandage and wear the dressing for three weeks.

3. Diseases of the Joints.

Synovitis is a primary inflammation of the synovial membrane alone. If other structures besides the synovial membrane are involved, the condition is known as "arthritis." Two forms of simple synovitis exist—namely, *acute* and *chronic*. Some surgeons speak also of *subacute* cases.

Acute Simple Synovitis.—The *causes* of acute simple synovitis are contusions, sprains, twists, and overuse, The causative influence of exposure to cold or damp has been much debated. It seems probable that in some cases cold produces vasomotor paresis of the vessels of the synovial membrane, a condition which may be followed by inflammation. In synovitis the membrane is red and swollen, and the joint contains an excess of turbid fibrinous fluid. If the inflammation advances, arthritis arises and sometimes blood is effused.

Symptoms.—The symptoms of acute synovitis are—pain, which is increased by motion of the joint, by pressure upon the articulation, and by a dependent position of the limb, which is worse at night. Pressure upon the cartilage does not cause pain, but friction of the synovial membrane at once develops it. The patient places the limb in the position which gives the greatest ease, and in this position the part becomes more or less fixed as the muscles about the joint are rigid. A fluctuating swelling is noted in a superficial joint, most marked between the ligaments, which swelling bulges out the synovial area and hides or obscures the articular heads of the bones. The swelling is due early to extensive secretion of synovia, and later to effusion of liquor sanguinis. Bulging takes place at points where the capsule is thin, and at such points fluctuation may be detected. Fluctuation in the elbow is sought for posteriorly. Fluctuation in the knee is sought for on either side in front. A large effu-

sion in the knee floats the patella up from the condyles. A small effusion in the knee can be detected by Fiske's plan, which is as follows: Tell the patient to bend forward at the hips, resting each hand on the front of the corresponding thigh. The anterior structures of the joint are relaxed, and, by tapping the patella, even a small effusion can be discovered. Bulging cannot be distinctly observed in the hip or shoulder, unless effusion is great. The skin over the joint is rarely reddened, but feels hot to the hand of the observer (over more superficial joints, but not over shoulder and hip); the joint is partly flexed; fever exists, varying in degree with the size of the joint, the acuteness of the attack, and the nature of the cause. Suppuration rarely follows simple synovitis, but it may do so, the area of synovitis being a point of least resistance to organisms in the blood or lymph. If suppuration takes place rigors occur, there is a septic temperature, and the joint soon gives evidence of containing pus. These evidences are violent pain, increased tenderness, dusky discoloration if the joint be superficial, greater muscular spasm, periarticular edema, and constitutional symptoms of sepsis. Traumatic synovitis without infection tends toward cure without suppuration if the patient is healthy, and after it ankylosis is rare.

Treatment.—In treating acute synovitis immobilize the joint. In severe cases place it in such a position that the limb will still be useful even if ankylosis occurs. In mild cases immobilize in the position of rest, apply leeches, and use the ice-bag or the Leiter coil. After a day or two apply gentle pressure, intermittent heat, and iodin and ichthyol. If the effusion is very great and persistent, and pressure, heat, and sorbefacients fail to remove it, aspirate with antiseptic care. If effusion recurs after respiration, apply a plaster-of-Paris dressing or use flying blisters and massage. A rubber bandage is often useful toward the termination of a case.

Chronic Synovitis.—Chronic synovitis follows acute synovitis or it may be chronic from the start. Many cases called chronic synovitis are in truth tubercular disease. The synovial membrane looks nearly natural, but is edematous, and the joint contains an excess of fluid. If the quantity of fluid is large, the disease is called "hydrops articuli," or "dropsy." A large amount of fluid in the knee-joint "floats" the patella upward. Tubercular infection is apt to occur in very prolonged cases. In prolonged chronic synovitis the synovial membrane thickens in some places, softens

in others, is often adherent, and the villous processes of the synovial membrane hypertrophy. If the membrane becomes extensively softened (pulpy degeneration), the softened areas bulge and caseation eventually occurs. In the knee-joint a traumatic synovitis is sometimes linked with inflammation of the semilunar cartilages. Roux tells us that this inflammation may be produced by a squeeze, a twist, or a direct force, but a squeeze is the common cause. Hyperextension of the knee may squeeze the cartilage, and so may attempting to rise from a stooping posture.[1] If this injury has taken place, the disability will be prolonged.

Symptoms.—In chronic synovitis pain is absent or is only present during exercise or from pressure, and is slight even then; there is some limitation of movement; passive motion may develop creaking or joint-crepitus; fluctuation is apparent; there is atrophy in the muscles about the joint; and the hypodermatic needle will draw out a viscid, straw-colored or bloody fluid.

Treatment.—For hydrops use rest and pressure. Pressure may be obtained by the application of Martin's rubber bandage. A plaster-of-Paris dressing is probably the best way to combine rest and compression. Massage, douches, frictions, passive movements, and flying blisters should be used. Painting the joint with iodin and spreading over it blue ointment, and rubbing in ointment of ichthyol (50 per cent. with lanolin) may do good. Counter-irritation by the actual cautery is a valuable expedient. Aspiration and the subsequent use of a plaster-of-Paris bandage may be tried in some cases. Some surgeons advise aspiration, washing out with salt solution, injecting a 5 per cent. solution of carbolic acid, and immobilizing. Incision and drainage constitute a radical but proper plan, in cases unamended by simpler methods. If pulpy degeneration exists, perform an excision or an erasion. If pus forms, incise at once and drain. Internally, treat any existing diathesis and give nutritious food, tonics, and stimulants. Chronic synovitis is often greatly benefited by the use of a hot-air apparatus. The limb is wrapped in flannel and is placed in an oven. The oven is heated by Bunsen burners. The temperature is raised to about 300° F., and the limb is subjected to this for one hour. The oven should be used daily, and as the patient becomes accustomed to it even a higher degree of heat can be tolerated. This high degree of heat can be borne only when it is perfectly dry. Any

[1] *Gaz. des Hôp.*, No. 125, 1895.

moisture scalds the patient. The Lentz oven has in it ventilation openings to get rid of moisture and the sweat is taken up by the flannel. This flannel must not be applied so thickly as to keep the heat notably from the joint nor must so little of it be used as to permit of its soaking with sweat. Fig. 164 shows the Sprague hot dry-air apparatus, and Fig. 165 exhibits a cross-section of the same apparatus. Dr. H. A. Wilson inserts in the oven humidin, a product

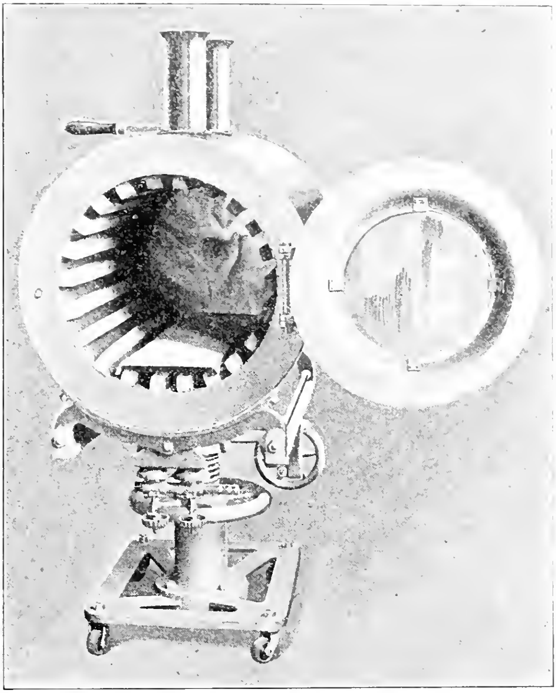


Fig. 164.—Sprague hot dry-air apparatus.

obtained in the purification of salt, which material entirely absorbs moisture. Cotton should not be used to wrap the limb, because, if the bottom of the oven becomes red-hot, the cotton may ignite and burn the patient. A physician or nurse should constantly watch the apparatus during its employment.[1]

Arthritis.—By this term is meant not only inflammation of a synovial membrane, but also of other structures composing and surrounding a joint. It may follow a traumatic

[1] H. A. Wilson, in *Annals of Surgery*, Feb., 1899.

synovitis; it may be due to pus organisms, to tubercle bacilli, to infectious diseases (gonorrhea and typhoid fever), to rheumatism, to gout, to syphilis, and to lesions of the spinal cord. Arthritis may be either acute or chronic.

Tubercular Arthritis (White Swelling; Strumous Joint; Pulpy Degeneration).—*Pathology and Symptoms.*—The predisposing causes of tubercular arthritis may be strains, blows, twists, or cold. The real cause is the bacillus of tubercle. The primary infection with tubercle bacilli is usually in the bone, though it may be in the synovial mem-

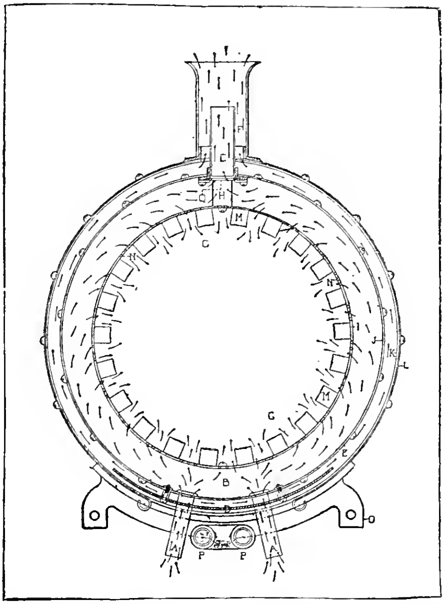


FIG. 165.—Cross-section of Sprague hot dry-air apparatus: A, A, air intakes; B, circulating air space; E, jacketed space for products of combustion; G, treatment-chamber; M, M, cork ribs; N, N, perforations admitting heated air; O, base holding apparatus; P, P, gas-burners.

brane, the joint-capsule, or the structures about the joint. If the primary infective focus is in the bone, and it usually is, a portion of the cartilage is destroyed and the joint is opened, or a sinus forms and perforates the synovial membrane. When tubercular inflammation attacks the synovial membrane granulation-tissue is formed, and the capsule and periarticular structures soon become involved in the process; the parts thicken and soften from caseation, and they may be covered with tubercles, though but little fluid is usually

effused into the joint. Some few cases present large joint-effusions. In the ordinary form of arthritis there occurs what is known as "gelatiniform degeneration;" the granulation-tissue is formed in large amount as fungous growths: the structures are markedly edematous and softened; the relaxed ligaments yield under pressure; the natural contour of the joint is lost, and it becomes spindle-shaped; all the structures, articular and periarticular, are glued into one mass; the skin about the joint is white, thick, and adherent, and in it one or more large veins are seen; fluctuation or pseudofluctuation is noted when caseation has occurred; pain is not often severe, but it can usually be elicited by certain motions or by firm pressure, but the pain will always be severe when the epiphysis is involved; the temperature of the part is somewhat elevated; deformity results from destruction of bone, cartilage, and ligament, from muscular spasms, and from the habitual assumption of certain attitudes to secure relief from pain. There is soon impairment of joint-motions. When the products of a tubercular arthritis caseate, the thick liquid seeks exit by forming sinuses from which caseous pus flows. If a sinus becomes infected with pyogenic cocci, and the joint itself becomes their prey, acute suppuration arises in the joint, and constitutional involvement is pronounced and perilous to life.

In pannous synovitis a large effusion is formed, there is but little granulation-tissue, though the tubercles are present in large numbers, and the ligaments and structures about the joint are slightly or not at all implicated. The diagnosis early in a tubercular joint is often difficult, and sometimes impossible, and the prognosis is always grave. In only a very few cases, even when recognized early, is a cure obtained without some impairment of joint-function. The best that can usually be accomplished is a cure with more or less ankylosis, fibrous or bony; and often ankylosis is complete. Long after the disease is apparently cured, it may break forth anew. Tubercular lesions may arise in a distant organ, or general tuberculosis may occur. Caseation is apt to produce severe constitutional disorder. Infection by pus organisms gives rise to grave danger of septicemia. Death is not unusual from exhaustion, from septicemia, from disseminated tuberculosis, from tubercle in an important organ, or from amyloid disease.

Treatment.—Constitutionally, the treatment is directed against the tubercular diathesis. Locally, rest is of the first importance, and it is maintained for many weeks, it being

obtained by splints, by a plaster-of-Paris bandage, or by extension appliances. The hot-air apparatus may be of some benefit. If it is employed it should be used daily, the limb being immobilized during the remainder of the twenty-four hours. Bier's plan of inducing congestive hyperemia may do good (p. 199). Aspiration can be used for fluid accumulations. Caseous masses are often let alone, or an aspirator is used and the joint drained, washed out with saline solution, and injected with an emulsion of iodoform and glycerin (10 per cent.). Injections of balsam of Peru or of iodoform emulsion about the joint once a week are efficient in some cases. If these means fail, if the patient gets worse, or if the condition of the sufferer renders dangerous the prolonged conservative course, operate, removing the entire diseased area by erasion, by excision, or by amputation. Always remember that an incomplete operation or a partial removal, unless it consists of simple drainage, is worse than no operation, as it opens the portals to systemic infection, and may be responsible for a general tuberculosis, septicemia, or pyemia.

Tuberculosis of Special Joints.—**Tuberculosis of the Sacro-iliac Joint** (Sacro-iliac Disease).—This is an uncommon affection, and is especially rare before the age of fifteen. The disease may begin in the joint, may arise in adjacent bones, or may result from a cold abscess burrowing into the joint. In some cases it is associated with extensive disease of the pelvic bones. The disease, if undetected, may lead to dissemination of tubercle, to abscess, or even to death.

Symptoms are often obscure. The disease is often confounded with vertebral caries, hip-joint disease, or sciatica. The patient limps on walking, but can stand on either leg; there is pain in the sacro-iliac joint, about the hip, and down the thigh; tenderness is manifest on pressure over the joint and on pushing the ilia together; there is fulness over the sacro-iliac joint; but the hip is not flexed unless iliac abscess exists.[1]

Treatment.—Rest in bed for months, using also a felt case for the pelvis. Counter-irritation by blisters and the actual cautery. In some cases injection of iodoform; in others incision and curetting. I have operated on four cases, with one death. In one case in the Jefferson Medical College Hospital the abscess was pointing in both the back and loin. Both areas were incised, the diseased bone was removed and the boy ultimately recovered.

Tuberculosis of the Hip-joint (Hip Disease; Morbus Cox-

[1] See A. G. Miller, *Edinburgh Med. Jour.*, May, 1895.

arius; Morbus Coxæ; Coxitis; Hip-joint Disease).—The primary lesion may be in the synovial membrane, but it is more often in the bone. It may begin in the acetabulum; it may begin in the femur. If it begins in the femur, it usually arises on "the distal side of the epiphyseal cartilage" (Senn). In some cases primary tuberculosis arises in the trochanter major, and may never involve the joint. When the synovial membrane becomes involved at any point, spreading throughout the joint is rapid. In many cases the articular cartilages are attacked, and in some cases the epiphyseal cartilage is destroyed. It is commonest in children, but it may arise in adults and even occasionally in those of advanced years; 62 per cent. of cases arise in children under ten years of age and 80 per cent. of cases occur before the twentieth year (Bryant). Traumatism and cold may be predisposing causes. The disease strongly tends to caseation and the formation of sequestra.

Symptoms.—It has been usual to divide the disease into three stages: (1) the stage of microbic deposition and multiplication, the products of the bacilli causing irritation and new growth; (2) the stage of progression, with formation of masses of granulation-tissue and effusion into the joint; and (3) the stage of caseation, with destruction of the joint and often of the structures about it. Bradford and Lovett[1] protest against this. They say: "It has been customary to divide hip-disease into stages, and to ascribe to these stages certain definite symptoms. Neither from a clinical nor a pathological point of view is it desirable to attempt such a division." As H. Augustus Wilson says: "Tubercular bone and joint disease should be considered as the primary invasion or incipiency, and all other symptoms should be regarded as results and not as an integral and necessary part of the trouble."

The symptoms of incipient coxalgia are slight and may be overlooked entirely. In a child there are night-terrors; on getting about in the morning the child shows some lameness, which wears off during the day, but it soon grows tired while playing and lies down to rest. There may be a slight limp; a slight adductor spasm may often be noted; some pain may occur in the hip on tapping the sole of the foot while the patient is recumbent with the leg extended; pain may be complained of at night in the hip, in the front of the thigh, or at the inside of the knee. The diagnosis in this stage is more or less problematical.

[1] *Orthopedic Surgery.*

As the disease progresses more positive symptoms are observed. The child limps; the adductor muscles are rigid; the hip is broadened by an effusion in the joint, and fluctuation may possibly be detected; the thigh-muscles are atrophied; the extremity is pushed forward, abducted, and everted (the patient tilts the pelvis so as to rest his weight on the sound limb). In some few cases adduction exists rather than abduction. The abduction, which is usual, releases tension of the fascia lata, and thus abolishes pressure upon the joint through lessening of pressure upon the great trochanter (Allis). The thigh is somewhat flexed. This flexion relaxes the psoas muscle and prevents pressure of its tendon upon the front of the joint (Allis). Pain exists, often sudden or starting, and is located in the joint, on the front of the thigh, and to the inner side of the knee in the course of the obturator nerve; the pain is aggravated at night; and full extension and complete abduction are not possible. The gluteal muscles waste, and the gluteal crease is on a lower level than is that of the sound side. The gluteal crease may be nearly or quite effaced, because of hypertrophy of the subcutaneous layer (Alexandroff). Jarring of the heel when the extremity is in extension causes pain in the hip. The above symptoms arise chiefly from unconscious efforts to obtain ease, from joint-effusion, reflex irritation, and involuntary or spasmodic muscular contractions. There is an appearance of lengthening, but it is only apparent, not real. The position is shown on Plate 7, Fig. 4. The fluid effusion may be absorbed or may find its way externally by means of sinuses. The latter condition is known as "abscess of the hip." The absorption of the exudate or the rupture of the capsule permits the contracting muscles to bring the head of the femur into firm contact with the acetabulum or its brim; the bones are worn away and destroyed, shortening results, abduction gives way to adduction, flexion is increased, and shortening occurs.

In advanced cases of coxalgia the head of the femur goes upward and outward upon the rim of the acetabulum, the thigh is flexed and fixed, and attempts at extension when the patient is recumbent cause the pelvis to tilt forward and occasion a marked lumbar curve (Pl. 7, Fig. 2), which is due to the pelvis moving with the femur as if ankylosed, and which disappears on flexion. In this condition adduction occurs because of the ascent and movement outward of the

head of the bone. Shortening is marked. After a hip-abscess finds an external outlet pyogenic infection is very apt to take place and suppuration arises, which is followed by that state which is designated as "hectic." If a cure follows advanced coxalgia, partial or complete ankylosis takes place; if death ensues, it may be due to septicemia, tuberculosis of the viscera, exhaustion, or amyloid degeneration.

Diagnosis is very easy in well-established cases of hip disease, but very difficult when the disease is incipient. Always make a systematic and thorough examination. Undress the patient and place him recumbent upon a table or a hard mattress, with the legs extended, and note if the heels are level and if the iliac spines are on the same level (depressed spine on the affected side means abducted extremity, the degree of which is determined by carrying the limb out until the spines are horizontal; elevation of the iliac spine on the affected side means adduction, the amount of which is determined by adducting the limb until the spines are horizontal (Fig. 166). Try all the movements belonging to the joint, to

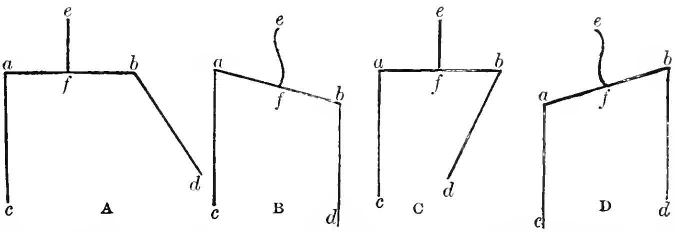


FIG. 166.—Positions in hip-joint disease (after the plan of Howard Marsh and Treves). A.—*e f*, lumbar spine; *b d*, limb fixed in flexion and abduction—useless for walking. B.—*e f*, lumbar spine. Patient corrects the condition in Figure A by curving the lumbar spine forward and rotating the pelvis on its transverse axis, thus making the femur point downward. The lumbar spine is curved laterally, the pelvis ascending on the sound side and descending on the affected side (apparent lengthening). C.—*b d*, limb fixed in flexion and adduction. D.—*e f*, curve of lumbar spine to correct condition in Figure C (apparent shortening).

detect any limitations; try if bringing down the knee produces lordosis (Pl. 7, Figs. 1, 2); look for swelling and for muscular wasting; feel if the head of the bone is enlarged; observe if motion produces pain or if pressure develops tenderness; and always carefully elicit the history of the attack, of the person, and of the family.

Hip disease may be confounded with spinal caries in which a psoas or a lumbar abscess has formed, with sacro-iliac disease, with infantile paralysis, with congenital dislocation of hip, with lordosis from rickets, with gluteal abscess, and with

bursitis of the gluteal bursæ. In hip disease there is always some lameness; pain may be severe or may be absent entirely, and may be in the hip or be referred to the front of the thigh or the inner side of the knee. Always remember that the pain is not characteristic, and that pain in the same localities may arise from aneurysm of the femoral or iliac arteries, from abscess in Scarpa's triangle, from caries of the lumbar vertebræ, from sacro-iliac disease, and from cancer of the rectum. Altered position of the limb, limitation of movement in the hip-joint, muscular wasting, and swelling soon arise in hip-joint disease.

In disease of the sacro-iliac joint examination shows that the movements of the hip-joint are unlimited and produce no pain, and that pain is developed by pressure over the sacro-iliac articulation and by pressing the ilia together. In infantile paralysis there is no pain, but there is paralysis with great muscular atrophy, which comes on with considerable rapidity. In spinal caries with psoas abscess the evidences of disease of the vertebræ are clear and the tubercular pus is located in the groin external to the femoral vessels. The tubercular pus of hip-abscess generally gathers under the tensor vaginæ femoris muscle, but it may reach Scarpa's triangle by passing through the cotyloid notch or through the bursa under the psoas muscle; it may even appear under the glutei. Matter from a caseating acetabulum may reach the interior of the pelvis and appear above Poupart's ligament.

In gluteal bursitis the symptoms last for many months, and do not remit as the symptoms of early hip disease are apt to do. The pain is but moderate, and is aggravated by exercise, but passes away on going to bed, and is felt back of the hip and back of the knee. There are a certain amount of limitation of motion and a positive limp, which arises early. In marked cases fluctuation can be detected in the upper gluteal region.[1]

Prognosis.—If the case of hip disease is seen early, the chances of cure are excellent in children, in whom the disease may be arrested at any stage. The longer the duration of the disease and the older the subject, the more unfavorable is the prognosis. Many months will be required to elapse before a cure can be effected, and advanced cases only get well by means of ankylosis with shortening and deformity. Hip disease may recur years after apparent

[1] See E. G. Brackett's important paper on "Gluteal Bursitis," in *The Transactions of the American Orthopedic Association*, vol. x.

cure, and a person who has had hip disease runs a strong chance of developing visceral tuberculosis.

Complications.—The complications that may accompany hip disease are the following: *Abscess*, as above noted. *Tubercular meningitis*, or the condition known as "acute hydrocephalus" or "water on the brain," may arise during the progress of the case or after apparent cure, and is apt to ensue upon incomplete operations. It is almost inevitably fatal. *Phthisis pulmonalis* is a rare complication, but is a common sequence, being apt to arise, sooner or later, after the hip disease is cured. *Amyloid, lardaceous*, or *waxy degeneration of viscera* follows upon profuse and long-continued suppurations, and is apt to arise in the liver, spleen, kidneys, or intestinal mucous membrane. Tuberculosis is not the only cause of amyloid degeneration, syphilis being responsible for at least 30 per cent. of all cases. In amyloid disease of the liver this organ is much enlarged, smooth, painless, and of increased consistency, there is no jaundice, the spleen is apt to be enlarged, and albuminuria is the rule. In amyloid kidney large amounts of pale urine of low specific gravity are voided; albumin is usually present in large amount, but may be absent; globulin may often be found, as may also hyaline, fatty, or granular casts; the patient is anemic, and dropsy usually exists. Test the hyaline casts with iodin for amyloid material. Amyloid changes are usually slow in onset, but they may be rapid; they are commoner in men than in women, and are most frequently encountered in individuals between the ages of ten and thirty. Slight amyloid change may be recovered from, but an extensive degeneration brings about a fatal result. Dickinson's theory of how this tissue-change is caused is that the flow of pus drains off from the body the alkaline salts, especially the salts of potassium, which drainage results in visceral depositions of de-alkalinized fibrin.

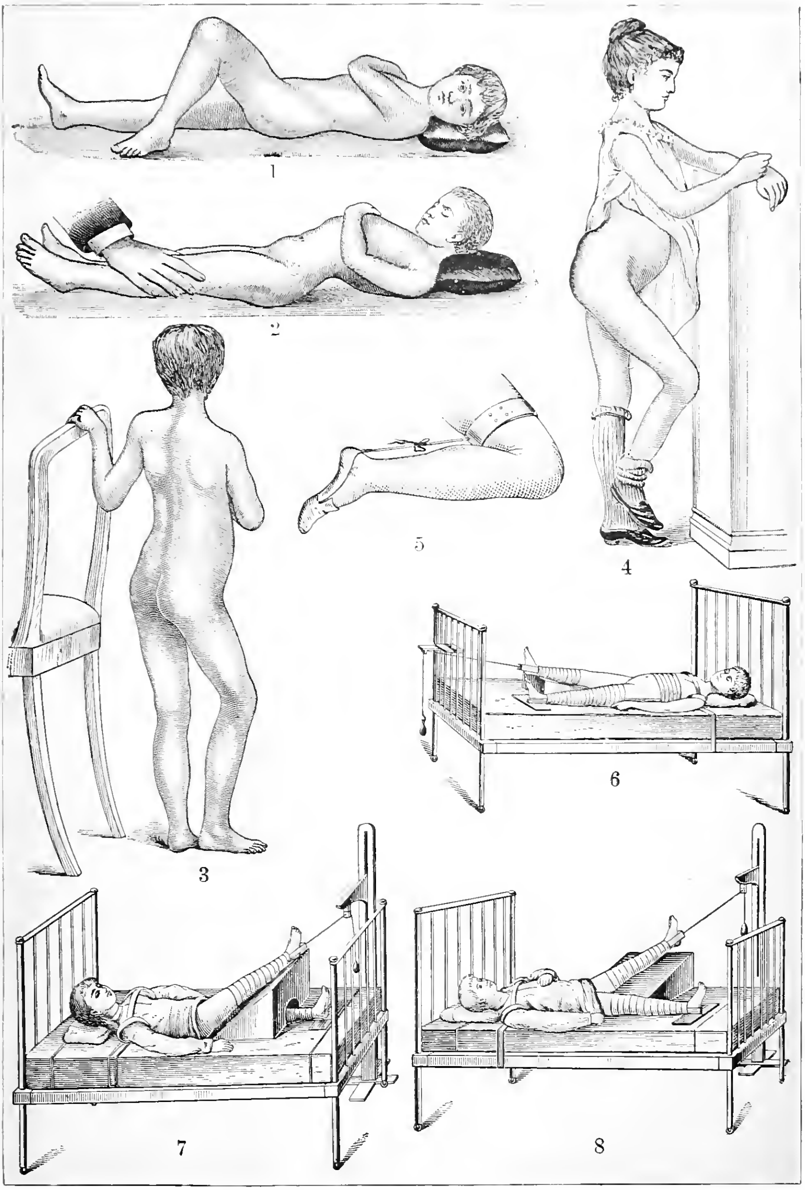
Treatment.—In incipient hip disease the treatment consists in rest. Place the patient upon a solid mattress and apply extension. In children under ten years of age, use a weight of from three to five pounds; in children between ten and twenty, use a weight of from five to eight pounds. A long splint is often applied to the sound side to keep the patient recumbent and horizontal. Always use a cradle to hold up the bed-clothing. Apply the extension in the long axis of the limb, the extremity being placed in the line of the deformity due to disease and being supported by pillows. In lordosis from thigh-flexion, raise the limb until

the iliac spine is straight (Pl. 7, Fig. 6). If the spine is depressed on the affected side, abduct the limb (Pl. 7, Fig. 8); if the spine is elevated, abduct the limb until the spines are horizontal (Pl. 7, Fig. 7). The object in taking these precautions is to enable the extension to separate the femoral head and the acetabulum. Extension will remove flexion in two weeks in a recent case and in the course of some months in an older case. As flexion is relieved remove the pillows and lower the leg so as to keep up extension in the long axis of the thigh. Abduction and adduction cannot be removed by extension.

Abduction demands no special treatment. In a movable joint it will disappear, and in an ankylosed joint it is an advantage, compensating by apparent lengthening for the shortening due to bone-absorption or to stunted growth of the limb. Adduction requires an addition of several pounds to the extension weight, the use of a long splint on the sound limb, and the drawing up of the sound limb by a rope and pulley toward the head of the bed. The weight used to pull the sound side toward the head of the bed is equal to that used to pull the damaged side to the foot of the bed. This expedient is used for a month or six weeks. In old cases where the weight will not bring about extension, anesthetize the patient, gently straighten the limb a very little, and reapply the weight.

Fig. 167.—Thomas's posterior splint.

Extension in a mild case must be continued for three months after the symptoms have disappeared, and in a severe case the period must be six months. The weight is gradually taken off; if symptoms recur, the weight is reapplied; if they do not recur, apply a traction splint or a plaster dressing, put a high-heeled boot on the sound limb, and send the patient out on crutches. In young children extension can be made while the child is in a wheeled carriage, thus enabling the patient to go out in the fresh air and sunlight. The general treatment is tonic and restorative. The joint is so deeply placed that external applications are useless. In the treatment of hip disease Thomas's splint (Fig. 167) is used by many, and it



1, 2. Effects on the Lumbar Spine of Flexing and Extending the Diseased Leg in Hip Disease (Albert). 3, 4. Positions in Coxalgia (Albert). 5. Strap-and-slipper Apparatus for Fracture of Posterior Portion of the Calcaneum (after Hamilton). 6. Extension in Hip Disease (Treves). 7. Extension of the Limb in a Flexed and Adducted Position (Treves). 8. Extension of the Limb in a Flexed and Abducted Joint (Treves).

may be combined with weight extension; or Sayre's splint (Fig. 168) may be employed. Wyeth's apparatus (Fig. 169) is a favorite with many American surgeons.

If the limb is in good position, or has been brought into good position, either by weight extension or straightening under ether, plaster of Paris is a useful dressing. It is put on from the toes up, and includes the entire extremity and also the pelvis. A patient dressed by plaster may get about on crutches when the sole of the other foot is raised. If

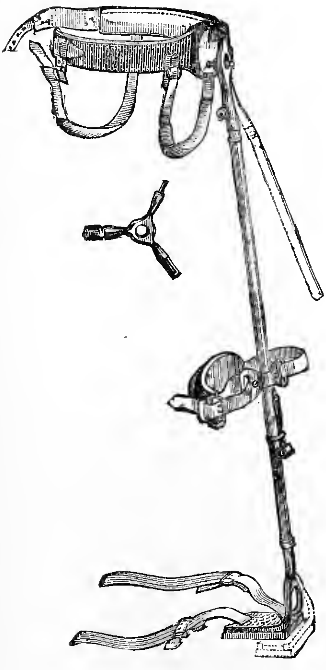


Fig. 168.—Sayre's long splint.

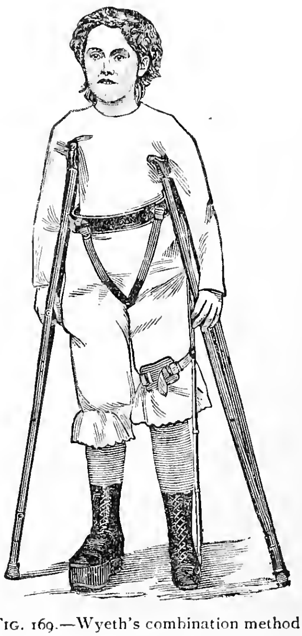


Fig. 169.—Wyeth's combination method.

a case, in spite of treatment, does not improve or becomes worse, use intra-articular injections of iodoform. Always try these injections before doing a resection. Sometimes they succeed and render resection unnecessary. Asepticize the surface, carry a small aspirating-needle into the joint, irrigate the joint with salt solution, and inject a sterile emulsion of iodoform and glycerin (10 per cent.). In one week, if reaction has ceased, repeat the injection. In another week repeat it again. It may be necessary to give

from ten to twenty injections. The proper spot for puncture is thus determined: Draw a line from a point half an inch outside of the middle of Poupart's ligament to the outer edge of the great trochanter. Puncture at the middle of the outer half of this line (DeVos).

If an abscess forms, incise it with the most thorough antiseptic care, let the fluid drain away, wash out with salt solution, remove any sequestra, inject with iodoform emulsion, insert a tube, and dress antiseptically. In some cases the sequestrum is extra-articular. In some cases no sequestrum is found. The old plan of not operating until rupture was seen to be inevitable was bad. To open early and antiseptically often means rapid healing, the prevention of burrowing, a lessened danger of visceral infection, and an earlier cure. Hectic will rarely arise if the abscess is opened with antiseptic care.

Excision of the hip is to be performed when the head of the femur is detached and lies loose in the joint; when profuse suppuration continues for a long time, and other methods fail to arrest it; when amyloid disease is beginning; or when very faulty position is inevitable without operation. Excision is an operation of considerable danger, and the older the person the greater the danger. Schede advocates arthrectomy in some case as a substitute for resection. Senn tells us that opinion as to resection has greatly changed of late, and the operation is advisable in all cases where fixation, extension, intra-articular and parenchymatous injections have failed to arrest the disease (Senn on *Tuberculosis of Bones and Joints*). When there is extensive disease of the femur, when excision has been tried and has failed, or when the patient has not the recuperative power to stand the long siege following excision, amputate.[1] Amputation of the hip-joint for tubercular disease is a very successful procedure.

Knee-joint Disease (White Swelling).—After the hip, the knee is, of all joints, the commonest site for tubercular disease. Knee-joint disease can begin as a synovitis, but oftener begins as tubercular inflammation of the femoral or the tibial epiphysis. The disease rarely attacks the bone above the epiphyseal line; a single focus only exists as a rule, and a sequestrum is rarely formed. In very rare instances the patella or the semilunar cartilage is primarily attacked. It may begin at any age, but is most common in children and young adults. If an acute synovitis ushers in the case, there may be a large effusion into the knee-joint and partial flexion, but

[1] See the admirable article of Howard Marsh in Treves's *Manual of Surgery*.

swelling is usually slight in knee-joint disease. Pulpy degeneration of the synovial membrane occurs; the joint enlarges; the ligaments soften; the skin becomes edematous, and muscular spasm arises. The leg is flexed; the bones are displaced backward and outward, the foot being everted; lameness exists, due chiefly to deformity. Pain may be absent, is often slight, and is rarely severe. When the disease begins in the bone or an epiphysis there are pain, tenderness, lameness, swelling, inability to extend the limb completely, sudden spasmodic muscular contractions, and final involvement of the joint. When an abscess forms, it may destroy the joint very rapidly or it may break externally.

Treatment.—In treating knee-joint disease employ general antitubercular treatment and locally apply iodoform ointment or guaiacol. A useful plan is to make a mixture of guaiacol and tincture of iodin or guaiacol and olive oil (1 : 4). Once a day the joint is exposed by removing dressings, is painted with this mixture, and the painted surface is covered with cotton-wool. Rest is of the first importance, and may be secured by the application of splints (Figs. 170, 171), the use of extension (Fig. 172), or the employment of a plaster-of-Paris bandage. In any case the patient must be kept in bed for a few weeks; he may then be permitted to go out upon crutches, wearing a high-heeled shoe upon the sound foot. In cases in which treatment is begun early the disease may often be arrested in from eight to twelve months. If the symptoms do not abate after a number of weeks, or if the condition grows worse and caseation occurs, aspirate, irrigate, and inject iodoform emulsion. Intra-articular injections are not unusually curative. Insert the needle in the angle between the outer edge of the patella and the ligament of the patella (DeVos). Repeat the injection in one week if reaction has abated, and continue as directed for the injection of the hip-joint. If this plan fails, incise the cap-

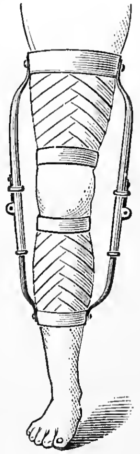


Fig. 170.—Sayre's knee splint applied.

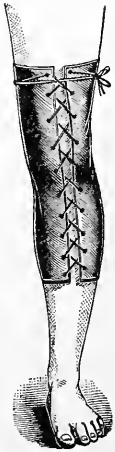


Fig. 171.—Hutchinson's knee-joint splint.

sule, remove all fragments and tubercular foci, irrigate with normal salt solution, inject iodoform emulsion, and sew up without drainage (Neuber's plan). A more severe case requires drainage. If these means fail, or if the case is too far advanced to permit of their use, open the joint and perform an excision or an erasion (page 605). Some cases demand amputation, which, if the patient's health is much impaired, is to be preferred to excision. Amputation is preferred to excision in very young children and aged people.

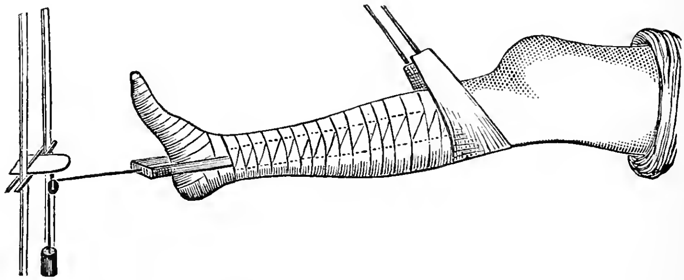


FIG. 172.—Sayre's double extension of the knee-joint.

Ankle-joint disease may begin in the synovial membrane, in the tibial epiphysis, or in the tarsus, but the origin is usually synovial. The *symptoms* are pain, swelling, lameness, limitation of joint-movements, and atrophy of the calf-muscles. Caseation often occurs, and sinuses form.

Treatment.—The treatment consists in the employment of antitubercular remedies, applications of guaiacol or iodoform ointment over the joint, and rest obtained by means of splints or plaster-of-Paris bandages. Caution the patient to avoid standing upon the diseased extremity. Injections of iodoform emulsion may do good. Insert the needle below the outer malleolus. When caseation occurs, it is often advisable to open, wash out with normal salt solution, inject iodoform emulsion, sew up the incision, and put up the ankle-joint in plaster. When joint-disorganization occurs, perform an excision or an erasion. Some cases demand amputation (Syme's amputation being preferred by some, amputation above the ankle being approved by many). Osteoplastic resection is sometimes advised (Wladimiroff-Mikulicz operation).

Shoulder-joint disease is not common; it is rare in children and is commonest in adults; it begins either in the synovial membrane or in the head of the humerus. The gle-

noid cavity is rarely attacked. Pain is slight, atrophy of the deltoid and other muscles is noted, the joint is stiff, and the scapula follows the motions of the humerus. Caries sicca is the usual cause of destruction. In many cases swelling is not obvious, the joint shrinking because of destruction of the head of the bone and contraction of the capsule (Senn). Abscess-formation is unusual. If an abscess forms, it may open in the axilla, the deltoid muscle, or at some far distant point.

Treatment.—In treating shoulder-joint disease employ anti-tubercular remedies and hygienic measures, and apply to the skin over the joint guaiacol or iodoform ointment. Put on a shoulder-cap, apply the second roller of Desault, and hang the hand in a sling. Maintain rest for at least four months. Aspiration and injection of iodoform emulsion are of great service in synovial tuberculosis. The needle is entered below the acromion, while the arm is held against the side and the forearm is at right angles to the arm and across the front of the chest (DeVos). If caseation occurs, open the joint, remove tubercular foci, wash with hot saline fluid, inject iodoform emulsion, and close without drainage, or, in a rather severe case, drain. In rare instances dead bone will have to be gouged away. Caries sicca may occur. Excision is sometimes required.

Elbow-joint disease may begin in the humerus or the ulna. The head of the radius is rarely the primary focus. In some cases the synovial membrane is first attacked. The disease is most frequent in young adults. The joint is swollen, its movements are somewhat limited, muscular wasting is pronounced, and pain is generally slight. Tubercular pus may form.

Treatment.—In treating elbow-joint disease, employ anti-tubercular foods, drugs, and hygienic measures; iodoform ointment or guaiacol locally; rest by means of an anterior angular splint (Fig. 173) and a triangular sling. Splints are to be worn for from four months to a year. Injection of iodoform emulsion may be useful. Insert the needle for injection by the side of the olecranon. It may become necessary to open the joint. If the condition is found to admit of it, Neuber's plan should be followed; but if there is advanced disease of the joint, drain with a tube or perform an erasion or an excision.

Wrist-joint disease may arise at any age, and is sometimes met with in late middle life, or even in old age. The joint presents a puffy swelling, loses its normal contour, and

becomes spindle-shaped. Hand-movements are impaired, pronation and supination cannot completely or satisfactorily be performed, the joint is stiff and partly flexed, the grasp is enfeebled, pain may be severe or slight, the skin is usually hot, and muscular atrophy is marked. This form of tuberculosis may begin in the synovial membrane, in the bones, or in the tendon-sheaths.

Treatment comprises the usual antitubercular measures and drugs, and the local application of guaiacol or iodoform ointment. Apply a Bond splint and sling or put on a plaster bandage, and maintain rigid rest for from four to six months. Aspiration and injection of iodoform emulsion are often useful. Enter the needle at the dorsal edge of the radial, styloid process, and again at the upper edge of the pisiform bone (DeVos). In some cases it is well to incise, wash with salt solution, in-

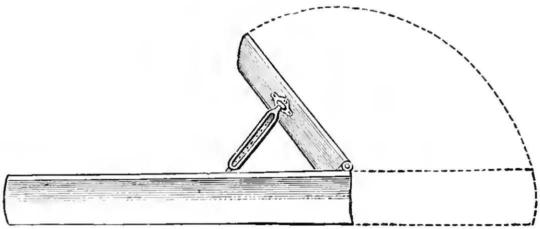


FIG. 173.—Stromeyer's anterior angular splint.

ject iodoform emulsion, and close without drainage. Severe cases demand incision and drainage with the maintenance of rest. A moderate amount of caries is treated by drainage and rest. Necrosis demands removal of the sequestra. Extensive caries requires excision.

Acute Suppurative Arthritis.—This infection is usually due to the staphylococcus pyogenes aureus or to the streptococcus pyogenes, which find entrance by means of a wound, by the spontaneous evacuation into a joint of the products of an osteomyelitis, by extension of suppurative inflammation through contiguous structures or by the blood-stream. In this disease all the joint-structures are involved and suppuration rapidly appears. It is very rarely due to gonorrhea, and sometimes to septicemia.

Symptoms.—The symptoms of acute suppurative arthritis are usually a chill followed by fever and a rapid pulse. There is severe pain, which is aggravated by motion and is worse at night; discoloration, heat, and edema of the skin;

partial flexion of the joint; fluctuation; and marked constitutional symptoms of sepsis. The joint tends to rapid disorganization, and fatal septicemia is very apt to occur. In pyemic arthritis several joints become infected.

Treatment.—The treatment in septic arthritis consists in prompt incision, evacuation, antiseptic irrigation, drainage, antiseptic dressing, and immobilization. Cure is followed, as a rule, by ankylosis, but in cases treated early the joint may be preserved.

Infective arthritis arises in the course of an acute infectious disease (such as erysipelas, typhoid fever, influenza, mumps, dysentery, diphtheria, measles, scarlatina, variola), and may be due to pyogenic cocci, to the specific micro-organism of the acute infectious disease, or purely to microbic products. Joint-inflammation arising in the course, or as a sequel, of an acute infectious disease may or may not suppurate.

Symptoms and Treatment.—If no suppuration takes place, the *symptoms* of the attack resemble those of rheumatism; if suppuration occurs, the symptoms are the same as those of acute suppurative arthritis, with which disease this form of infective arthritis is identical. Suppuration rarely occurs. Ashby has well described the arthritis which sometimes follows scarlatina. It involves the wrists, finger-joints, tendons of the forearms, the knees, ankles, or spine. The joints are painful, but are rarely much swollen or discolored (Howard Marsh).

That the organism of typhoid may inflame the joints is proved (Klemm, Quincke, and others), but whether it does cause suppuration has been disputed. Some claim that mixed infection induces suppuration. The typhoid bacilli enter the bones in many typhoid cases and sometimes cause bone-disease. Joint-disease is more common than bone-disease. Typhoid disease of a joint begins when the fever is abating, and more than one joint may be involved. Typhoid joints may recover permanently, may become ankylosed, may dislocate, or the joint-disease may lead to a fatal sepsis. We can distinguish infective arthritis from rheumatism by the fact that it does not migrate, and is uninfluenced by antirheumatic remedies. In slight cases the synovial membrane only is involved; in more severe cases capsule, cartilages, ligaments, and even bones are involved. Some cases suppurate. Keen tells us that septic typhoid arthritis results from a mixed infecton with typhoid bacilli and pyogenic bacteria, and is identical in symptoms and progress with an

ordinary septic arthritis. The same author points out that typhoid arthritis proper may be monarticular or polyarticular, the monarticular form being the most common, and the hip-joint being the articulation most liable to attack. In most cases typhoid arthritis causes but little pain. The swelling is marked, although in the hip it is concealed. Pus rarely forms. Keen calls attention to the fact that in the eighty-four cases he collected, spontaneous dislocation occurred in forty-three, nearly all in the hip.[1]

Treatment of a mild case, as for simple synovitis: if there is much fluid in the joint, aspirate and wash out with normal salt solution. If pus forms, open, irrigate, and drain.

Gonorrheal Arthritis or Gonorrheal Rheumatism.—During the progress of gonorrhea every rheumatic attack is not gonorrheal rheumatism, for ordinary rheumatism is just as likely to arise when a man has clap as when he has not this malady. Furthermore, the term is inaccurate, as gonorrheal rheumatism is not rheumatism at all, but is an infective disorder of the joints or of the synovial membranes, the infective material being contained primarily in the urethral discharge. Occasionally this form of arthritis arises from gonorrheal ophthalmia (Heiman's case); it sometimes, though rarely, arises during the height of a gonorrhea, but it is more frequently met with in chronic cases or when the intensity of the inflammation is abating in acute cases. Men suffer from gonorrheal arthritis far more frequently than do women, and the seizure is very apt to recur again and again. In some cases many joints are involved, but in most cases only a few joints suffer. Osler states that the knees and ankles are most apt to be involved in gonorrheal rheumatism, and that this form of arthritis is peculiar in often attacking joints that are apt to be exempt in acute rheumatism ("the sternoclavicular, the intervertebral, the temporomaxillary, and the sacro-iliac"). There are two forms of gonorrheal rheumatism, an acute and a chronic form.

Changes In and About the Joint.—The inflammation of gonorrheal arthritis may be located around rather than in the joint, and especially in the tendon-sheaths. Suppuration is unusual, but it may occur in joints and in tendon-sheaths Cultivation of the exudate may or may not show the gonococci. Cover-glass preparations stained by Gram's method may show gonococci. Osler suggests that the non-suppurative cases are due to the action of toxins taken up from the

[1] Keen on *The Surgical Complications and Sequels of Typhoid Fever.*

area of primary infection, and that the suppurative cases are due to infection with pyogenic bacteria.

Symptoms.—The acute form attacks as a rule but a single joint, but may attack several joints. The joint trouble begins with great suddenness, and is often ushered in by chilly sensations or by a distinct chill. Moderate fever arises. The pain in the joint, severe from the first, becomes atrocious. In superficial joints the skin is red and hot, and peri-articular edema is very evident. The fluid in the joint is in most cases serous, but may become purulent. If it becomes purulent, the fever becomes very high and chills may occur.

A chronic condition may follow the acute, but the condition may be chronic from the start. The symptoms resemble those of the acute form, but are far milder, although acute exacerbations may occur. The joint-fluid is usually serous.[1] In gonorrheal arthritis there may be transitory, intermittent, and wandering pain in and about the joint, without any other symptom; one or more joints may become swollen and painful, and moderate fever may develop. One joint, especially the knee, may swell to an enormous extent, pain, peri-articular edema, redness, and fever being absent (hydrarthrosis, or dropsy of a joint). Suppuration in this form is rare. The tendons, the tendon-sheaths, the bursæ, and the periosteum may inflame. Whether the joints are inflamed or not inflamed, the tendon-sheaths about the wrist and ankle and the retrocalcaneal bursæ are apt to suffer. In some cases numerous bursæ are involved. A case of gonorrheal arthritis is often very hard to check. It may last for a long period, and tends to recur again and again. Iritis, pleuritis, endocarditis, and pericarditis have been observed as complications. In some cases gonococci have been found in the joint-fluid; in other cases they have not been found. It seems probable that in mild cases only toxins reach the joints.

The *diagnosis* between gonorrheal arthritis and acute rheumatism rests chiefly on the great chronicity, the slight degree of fever, the excessive tendency to recurrence, and the absence of profuse acid sweats in gonorrheal rheumatism; and on the shorter course, the higher fever, the profuse acid sweats, the lesser tendency to rapid recurrence, the greater proneness to symmetrical involvement, and the great liability to cardiac and visceral complications in rheumatic fever. Furthermore, in gonorrheal arthritis a gonorrheal infection (urethral or ocular) certainly exists or recently

[1] See Schuller in *Aerztl. Pract.*, No. 17, 1896.

existed; in ordinary rheumatism a urethral discharge may, of course, happen to be present. Gonorrheal arthritis is apt to affect certain joints which acute rheumatism rarely attacks.

Treatment.—The salicylates, the alkalies, and salol are useless; iron, arsenic, and strychnin are of some benefit. Quinin is distinctly helpful in some cases. Iodid of potassium seems to be of some value. The inflamed joints should be wrapped in cotton and bandaged, and every day a little blue ointment should be rubbed into the skin about them. If the inflammation lingers, use the hot-air oven, massage, and gentle passive motion, apply blisters, or counterirritate with the hot iron. If the inflammation still lingers, or if it becomes worse, aspirate, wash out the joint with hot normal salt solution, and inject iodoform emulsion. If pus forms, incise, irrigate, drain, and immobilize.[1]

Rheumatic Arthritis.—Acute rheumatism is a self-limited febrile malady whose characteristic features are polyarthritis, profuse acid sweats, and a tendency to heart-involvement.

Symptoms of Acute Rheumatism.—In acute rheumatism the case begins with malaise and fever, and one or more joints become affected. The inflammation spreads from joint to joint, is apt to be symmetrical, and when it arises in fresh joints usually disappears quickly in those previously affected. The temperature is high, the skin sweats profusely, the joints are red, swollen, hot, and excruciatingly painful, and the structures about the joints are edematous. After a short time the inflammation subsides in one joint and passes into another, the joint first attacked regaining its functions. Suppuration does not take place. Anemia is pronounced, exhaustion is profound, the sweat is sour, the saliva is acid; the urine is acid, scanty, high-colored, often contains albumin, and is deficient in chlorids. Cardiac disease is apt to be produced (endocarditis, pericarditis, or myocarditis). Nodules may form upon fibrous structures, hyperpyrexia is not unusual, and cerebral or pulmonary complications may occur.

Chronic rheumatism rarely follows repeated attacks of acute rheumatism, but rather arises insidiously in people who have been exposed to cold and damp, who have suffered from poverty, hardship, and privation, or who have had much worry. The capsule and the tendon-sheaths thicken, and there is usually but little effusion in the joint, but the ar-

[1] See Schuller, *Aerztl. Pract.*, No. 17, 1896, and *Monats. über d. Krankheiten d. Harn. und Sexual Apparatus*, 1897, p. 30.

ticulation becomes stiff and painful. The joint-cartilages are occasionally eroded. Muscular atrophy occurs.

Symptoms of Chronic Rheumatism.—In chronic rheumatism the affected joints are stiff and painful and are a little swollen, but not red. Dampness and cold aggravate the symptoms. One joint or many may be affected, but usually several are involved. Passive movements cause the joint to creak and develop crepitus in the tendon-sheaths. The muscles are wasted. The joints may ankylose. Anemia is usually pronounced. There is no fever and no tendency to suppuration, and the disease is incurable.

The *treatment* of acute rheumatism comprises the use of alkalies, salicylates, etc. (See a book upon practice of medicine, as acute rheumatism is in the physician's province.) In chronic rheumatism maintain the general health of the patient, give courses of iron, arsenic, and strychnin, and an occasional course of iodid of potassium or a salt of lithium, and, if possible, send him every winter to a warm climate. Turkish baths give considerable temporary relief. The waters and regimen of Carlsbad and Vichy are of positive though temporary benefit, and the sufferer may obtain relief at the hot springs of Virginia. The patient must avoid damp and must wear woollens. Frictions, the douche, massage, flying blisters, counterirritation with the hot iron, ichthyol ointment, and mercurial ointment are of benefit. Subjecting the diseased joint to a very high temperature by placing it daily in a hot-air apparatus often does great good. In partial ankylosis it is proper in some cases to give ether and break up the adhesions.

Gouty arthritis, which appears especially in the smaller joints (as the fingers and the metatarsophalangeal joints of the great toes), is due to a deposition of urate of sodium in the joint and in the periarticular structures. The irritant urate of sodium causes inflammation, inflammation leads to the formation of granulation-tissue, granulation-tissue is converted into fibrous tissue, and the fibrous tissue contracts and thus deforms the joint and limits its mobility. A great mass of urates in a joint constitutes a "chalk-stone."

Symptoms.—The premonitory symptoms may be observed for a day or so, but the acute seizure usually occurs early in the morning, the patient, as a rule, being aroused by excruciating pain in the metatarsophalangeal articulation of one of the great toes. The joint swells, and the skin over it feels hot to the touch and becomes red and shiny. There is often considerable fever. After a few hours the intensity of the seizure

abates, only to recur again with renewed violence early the next morning, these remissions and recurrences taking place for six or eight days, when the attack subsides. In patients with chronic gout many joints are stiffened and deformed as a result of repeated attacks. Chalk-stones form, and the skin above them may ulcerate. Such patients are chronic dyspeptics, have high-tension pulses, their hearts are hypertrophied, and their urine contains albumin and casts.

The *treatment* of gouty arthritis belongs to the physician, and not to the surgeon, although to the latter the symptoms of the disease should be known, so that it may be diagnosticated from other maladies.

Osteo-arthritis (Rheumatoid Arthritis; Arthritis Deformans; Rheumatic Gout; Paget's Disease).—In this disease, which is not a combination of gout and rheumatism, the synovial membrane and cartilages are affected, the peri-articular structures are involved, and masses of new bone are formed.

Osteo-arthritis has, as John K. Mitchell pointed out, a probable nervous origin. It arises especially in persons who have been worried, driven, and harassed. There is apt to be muscular atrophy; trophic lesions of the hair and nails are likely to appear, and the symptoms are disposed to be symmetrical. The causative lesion has not been determined. The disease is commoner in women than in men. The greatest liability exists between the ages of twenty and thirty, but children may acquire the disease, and it may also be developed in people beyond middle life. Apes in captivity may develop it. Arthritis deformans may attack the rich or the poor; it does not result from gout, nor does it often follow rheumatism; it is not caused by damp and cold; and only in rare cases does it arise after traumatism of a joint.

Osteo-arthritis differs from gout in the entire absence of urate deposit, and it differs from chronic rheumatism in the extensive alterations in the joint-structures. The changes begin in the cartilage; the cartilage-cells multiply, the intercellular substance degenerates, the pressure of the bone causes thinning, and at length the cartilage is entirely destroyed and the bone is exposed. The exposed bone is altered in shape, is hardened, and is worn away in the center, the periphery increasing in thickness by ossific deposit; the center deepening by absorption. The margins are not only thickened, but are bulged and lengthened by deposit. The fringes of the synovial membrane hypertrophy and mul-

tiply, and some of them are apt to break off (loose cartilages). The capsule and the ligaments of the joint, as a rule, become fibrous and contract; but they may soften, relax, and permit of dislocation. The joint usually contains no effusion, but in some cases there is great effusion (hydrarthrosis). The tendons about the joint may become fibrous and contracted, they may ossify, they may be separated from the bone, or they may be destroyed entirely. Deformity is marked and motion is limited. The fingers, when involved, show nodules on the sides of the joints (Heberden's nodules). The vertebræ may be involved. Almost all the joints may suffer. Suppuration does not occur.

Symptoms.—Charcot divides osteo-arthritis into three forms, and gives their symptoms, as follows:

(1) *Heberden's nodosities*, which condition is commoner in women than in men, comes on between the ages of thirty and forty, and is especially common in neurotic subjects. The interphalangeal joints become the victims of attacks of moderate swelling and of some tenderness, which attacks are not severe, but recur again and again. After a time small hard swellings (nodosities) appear upon the sides of the dorsal surfaces of the second and third phalanges, remain permanently, and slowly increase in size. The joints become stiff and creak on movement, the cartilages are destroyed, and contractions and rigidity develop, but there is no fever and the larger joints are not involved. The malady is incurable.

(2) *Progressive rheumatic gout*, which may be acute or chronic. The *acute* form begins as does rheumatic fever. There are moderate fever and swelling, without redness, of a number of joints, of bursæ, and of tendon-sheaths; the joints are stiff and crepitate, and are apt to be symmetrically involved; muscular atrophy begins early and rapidly becomes decided; pain is slight. This acute form is apt to arise in young women after pregnancy, but is not unusual at the climacteric and in children. Anemia always exists. The case is apt to advance progressively until a number of joints are firmly locked, when it may become stationary. Another pregnancy will develop anew the acute symptoms. In the *chronic* form swelling and pain on movement are noted in certain joints. The involvement is apt to be symmetrical. Attacks of swelling and pain alternate with periods of quiescence, but the disease does not cease its advance. Articulation after articulation is attacked by the malady until almost all the joints are involved; deformity and stiff-

ness become pronounced, and pain may or may not be severe. There is no fever. Muscular atrophy is marked.

(3) *Partial rheumatic gout* attacks one articulation, and it is most often met with in old men. It may fix itself on the vertebral column, on the knee, on the shoulder, on the elbow, or on the hip. The joint grates, and becomes stiff, swollen, and deformed; the muscles atrophy; there is usually pain, but fever is absent.

Osteo-arthritis or partial rheumatic gout of the hip-joint rarely occurs before the age of forty-five, but is occasionally, though very rarely, met with in persons under twenty-five. If the disease arises in an elderly person, it is often called morbus coxæ senilis. In some cases only the hip-joint is attacked, in many cases other joints are also diseased. Osteo-arthritis of the hip may follow an injury. Usually the disease is unconnected with traumatism, begins very gradually, and advances slowly. There is pain in and about the joint, often mistaken for sciatica, and there is increasing stiffness. The pain and stiffness are worse when the patient first moves after resting. Lameness becomes noticeable, and grating can be detected in and about the joint. The symptoms get gradually worse, although at times they may seem to improve for a brief period. The lameness and the stiffness are greatly aggravated, and the pain becomes very severe, even when at rest. Shortening takes place, the trochanter ascends above Nélaton's line, the limb is usually abducted, but in very rare cases is adducted, and finally ankylosis occurs.

Partial rheumatic gout of the vertebral articulations causing fixation is called "spondylitis deformans" (p. 584).

Treatment.—Osteo-arthritis cannot be cured, but in some cases it remains stationary for many years. Treat the anemia by iron, arsenic, nourishing food, and have the patient be out in the fresh air as much as possible. Debility is met by the administration of strychnin. Hot baths of mineral water do good. It is claimed that the hot-air apparatus is of service. Douches improve these cases, but electricity is useless. Counterirritants do no good. Massage retards the progress of the case, relieves the pain, aids in the absorption of effusion, and delays fixation. During an acute exacerbation the joint should be put at rest for a time and evaporating lotions applied. In an exacerbation in disease of the hip the patient should be put to bed and have extension applied. The patient is unfortunately liable to develop the opium-habit. If dropsy of a joint arises, try compression with a Martin bandage,

and, if this fails, aspirate and wash out the joint with a 2 per cent. solution of carbolic acid. Patients with rheumatic gout do best in a warm, dry climate. Cod-liver oil does good, as it improves nutrition and hence retards the progress of the disease. Do not be tempted to immobilize the joints beyond a day or two: fixation only hastens ankylosis. Howard Marsh[1] points out that, as a rule, but little good comes from manipulation. He makes the following exceptions: When one joint only is affected; when the joint is very stiff but not very painful; when the patient is in good general health and is not beyond middle age.

Charcot's Disease (Tabetic Arthropathy; Charcot's Joint; Neuropathic Arthritis).—This condition is an osteo-arthritis due to trophic disturbance, arising in a sufferer from locomotor ataxia, and is anatomically identical with osteo-arthritis, which was described above. The knee is most apt to be attacked, and the hip suffers more often than any joint but the knee. The disease begins acutely, often as a sudden effusion, which after a time disappears. Pain is slight or is absent, there is no constitutional involvement, and the condition is unconnected with injury. The bones and cartilages are rapidly destroyed; fracture is apt to occur; the joint creaks and grates; the softening and relaxation of ligaments permit an extensive range of movement; great deformity ensues; dislocation is apt to occur; muscular atrophy is decided; and pus occasionally, though very rarely, forms.

Treatment.—The treatment of Charcot's disease consists in the wearing of an apparatus to sustain the joint. Resection is recommended by some, but most surgeons do not advise its performance.

Osteo-arthropathie Hypertrophiante Pneumique (Marie's Disease).—A condition associated with, and possibly springing from, pulmonary disease, and characterized by enlargement of joints, thickening of the finger-ends, and the formation of a dorsolumbar kyphosis. The joints are painful, the skin undergoes pigmentation, and profuse perspiration is often present. The head entirely escapes in this disease, which immunity marks a distinction from acromegaly.

Hysterical joint (Brodie's joint) is a condition mostly encountered in young women. The disease occurs most commonly in the knee and the hip, and often follows a slight injury which acts as an autosuggestion, a latent hysteria

[1] *Diseases of the Joints and Spine.*

being awakened into action and localized, though severity of the injury does not determine the severity of the symptoms. The disease may ensue upon a synovitis or an arthritis, or may arise without apparent cause. The patient complains of pain in and stiffness of the joint, resists passive motion strenuously and claims that it causes much pain. There is occasionally some muscular atrophy from want of use, and the joint is a little swollen. The skin is hyperesthetic, and a light touch causes more pain than does deep pressure. The muscles may be rigid. The joint may be maintained either in flexion or in extension, but it is rarely in the exact degree of flexion assumed for ease in a true joint-inflammation, and the position is apt to be changed from day to day or from hour to hour. The skin is usually pale and cool, but may be red and hot, because of hyperemia. A periodically developed heat may be observed, especially at night, accompanied apparently by much pain. The alleged pain in some cases is a neuralgia, but in most cases is a pain-hallucination. There is no effusion into the joint, and swelling does not exist, although occasionally there is slight periarticular edema. In some rare cases organic disease arises in a hysterical joint.

Hysterical phenomena are seldom isolated, but are associated with certain stigmata which may be latent. These stigmata are concentric contraction of the visual fields, pharyngeal anesthesia, convulsions, hysterogenic zones, globus hystericus, clavicus hystericus, zones of anesthesia, especially hemianesthesia, and hyperesthetic areas. Such patients are predisposed by inheritance, and have previously, as a rule, had nervous troubles. Hysterical phenomena, be it remembered, lack regularity of evolution, and are produced, altered, or abolished by mental influences and physical sensations which are without effect in causing, modifying, or curing organic disease. The general health, as a rule, is good, but neurasthenia may coexist. In examining these patients the observer will note that the symptoms disappear when the attention is diverted; that they are out of all proportion to the local evidences of disease; that there is no sign of joint-destruction; and that a light touch may cause more pain than does firm pressure. If the patient is anesthetized, perfect joint-mobility will be found.

Treatment.—The treatment in hysterical joints comprises attention to the general health, the employment of nourishing and easily digested food, the prevention of constipation, and the administration of tonics if they are needed. The

surgeon must dominate his patient's mind and make her realize that he is master of the case. He is to be an inexorable but just ruler—never a brutal or a cruel one. If possible, send the patient away from the harmful sympathies of her home and let her have the rest-treatment of Weir Mitchell. Local remedies applied to the joint do harm, as a rule, by concentrating afresh the patient's attention upon the articulation, although the hot iron sometimes does good. Suggestion in the hypnotic state may be tried. The use of morphin should be avoided as being the worst of enemies. Never immobilize the joint, and always use massage, passive motions, and frictions.

Neuralgia of the joints as an independent, isolated affection is extremely rare, though as a complication of other diseases it is by no means uncommon. The neuralgia is more often outside of the joints than in them, and is especially frequent in the knee and the ankle. Joint-neuralgia may arise in any person, but it is more commonly present in young neurotic females. The pain may be persistent, or it may occur in periodic storms, and it is often associated with neuralgia in other parts. The pain may be dull and aching, but it is more often sharp and shooting. Joint-neuralgia is associated with tenderness on pressure, soreness on motion, often with transitory swelling without redness, and sometimes with numbness of the extremities. The *diagnosis* depends on the temperament of the patient, the sudden onset of the pain, the absence of constitutional symptoms, and the free mobility of the joint, especially under ether. Articular neuralgia may depend upon disease or injury of the central nervous system, upon malaria, syphilis, neurasthenia, rheumatism, gout, hysteria, and neuritis, and may be due to reflected irritation, especially from the ovaries, the uterus, or the rectum.

Treatment.—The treatment to be observed in joint-neuralgia is to maintain the general health. Examine for a possible exciting cause, and, if found, remove it. Give a long course of iron, quinin, and strychnin or arsenic. In rheumatic or gouty subjects administer suitable drugs and insist upon the use of a proper diet. During the attack use phenacetin. Morphin must occasionally be given in severe cases, but be careful of it, and never tell the patients they are taking it, as there is a possibility of their forming the opium-habit. Locally, employ frictions, ointment of aconite, heat, and keep upon the part a piece of flannel soaked in a mixture of soap-linament, laudanum, and chloroform (Gross).

Never allow the joint to stiffen; any tendency to stiffness should be met by daily massage, frictions, passive motion, and hot and cold douches. In some rare cases nerve-stretching or neurectomy becomes necessary.

Articular Wounds and Injuries.—A *penetrating* wound is very serious, and it may be due to a compound fracture, to a compound dislocation, to a gunshot-wound, or to a stab. If a bursa near a joint be injured, secondary penetration may occur as a result of suppuration. In a penetrating wound, besides pain, hemorrhage, and swelling, there is a flow of synovial fluid. A small amount of synovia flows from an injured bursa, a large amount from an open joint.

Treatment.—If a joint is opened aseptically (as when incised by the surgeon), the wound heals nicely under rest and antisepsis. If a joint is opened by a septic body, suppurative arthritis is apt to arise, and the surgeon endeavors to prevent it by asepticizing the surface, irrigating the joint, draining, applying antiseptic dressing, and securing rest. Normal salt solution is the best agent for irrigation, as it does not injure joint-endothelium. Active antiseptics are apt to lessen tissue-resistance, and thus may actually favor infection. In gunshot-wounds, if antisepsis is not employed, suppuration is inevitable; hence military surgeons in the past, as a rule, have advocated amputation or excision in gunshot-splinterings of large joints. In these injuries the surface is sterilized, the wound is enlarged, the finger is introduced to discover and remove foreign bodies, through-and-through drainage is secured, a tube is inserted, the joint is irrigated, antiseptic dressings are applied, and the extremity is placed upon a splint. Very severe cases demand resection or even amputation. Ankylosis, more or less complete, follows a gunshot-wound of a joint. If the joint suppurates, the drainage must be made more free, sinuses must be slit up and packed, sloughs must be cut away, dead bone must be gouged out, and the patient must be placed upon a stimulant and tonic plan of treatment. The above remarks do not apply to wounds inflicted with the modern military projectile. Such wounds are not of necessity infected, and recovery may be prompt and uneventful if the surface is sterilized and antiseptic dressings and splints are applied.

Sprains.—A sprain is a joint-wrench due to a sudden twist or traction, the ligaments being pulled upon or lacerated and the surrounding parts being more or less damaged. A sprain is often a self-reduced dislocation (Douglas Graham). The

joints most liable to sprains are the knee, the elbow, and the ankle. The smaller joints are also often sprained, but the ball-and-socket joints are infrequently sprained, their normal range of free movement saving them; they do occasionally suffer severely, however, as a result of abduction. In a bad sprain the ligaments are torn; the synovial membrane is contused or crushed; cartilages are loosened or separated; hemorrhage takes place into and about the joint; muscles and tendons are stretched, displaced, or lacerated; vessels and nerves are damaged; the skin is often contused; and portions of bone or cartilage may be detached from their proper habitat, though still adhering to a ligament or tendon (sprain-fractures). Sprains are commonest in young persons and in adults with weak muscles. They happen from sudden twists and movements when the muscles are relaxed. A large part of the support of joints comes from muscles, and when they are suddenly caught unawares they do not properly support the joint, and a sprain results. A joint once sprained is very liable to a repetition of the damage from slight force. Sprains are common in a limb with weak muscles, in a deformed extremity in which the muscles act in unnatural lines, and in a joint with relaxed ligaments.

Symptoms.—There is severe pain in the joint, accompanied by general weakness. Nausea, vomiting, and even syncope may occur. There is impairment or loss of ability to move the joint. The above-described condition is succeeded by a season of relief from pain while at rest, numbness being complained of, and pain on motion being severe. Swelling arises very early if much blood is effused. In any case swelling begins in a few hours. Extensive effusion, by separating joint-surfaces, produces slight lengthening of the limb. Movements of the joint become difficult or impossible; the tear in the ligament may sometimes be distinctly detected by the examining fingers; pain and tenderness become intense; joint-crepitus will be manifested; and in a day or two discoloration becomes marked. Moullin and others have pointed out that when a muscle is strained the skin above it becomes sensitive, especially at tendinous insertions over joints. As muscles are invariably strained when a joint is sprained, there is always some cutaneous tenderness. There is also tenderness over a sprained joint due to capsular injury, bands of adhesions, etc. Tenderness is apt to arise at certain reasonably fixed points: in a hip-joint injury it is found behind the great trochanter, in a knee-joint injury by the side of the patella, in an ankle-joint

injury to the inner side of the external malleolus (Culp). When the vertebral articulations are sprained the muscles of the back are rigid, the skin is often sensitive, pain may be awakened by pressure or by certain movements, but there is no sign of cord injury in an uncomplicated case.

Diagnosis and Prognosis.—Sprain-fractures can be diagnosticated with certainty only by the *x*-rays. In the *diagnosis* of a sprain, fracture and dislocation must be considered. In fracture, crepitus and mobility exist; in dislocation, rigidity. The diagnosis of sprain should be made by a consideration of the joint involved, of the age, of the nature of the force, of the length of the limb, of the fact that the patient could use the joint for at least a short time after the accident, and of the local feel and movements of the part. In some cases examine under ether, in some apply the *x*-rays. Injuries about the ankle which we would have formerly regarded as sprains, are often shown by the *x*-rays to be fractures. The *prognosis* depends on the size of the joint, on the extent of laceration, on the amount of intra-articular hemorrhage, and on the age of the patient. The danger is ankylosis. In rare cases after a sprain of the hip-joint osteoarthritis arises. In some few cases after a sprain of the hip the head of the bone undergoes absorption.

Treatment.—In a mild sprain apply at once a silicate or plaster dressing. The first indication after the infliction of a severe sprain is to arrest hemorrhage and limit inflammation. For the first few hours apply pressure and an ice-bag. Wrap the joint in absorbent cotton wet with iced water, apply a wet gauze bandage, and put on an ice-bag. After some hours place the extremity upon a splint and to the joint apply flannel kept wet with lead-water and laudanum, iced water, tincture of arnica, alcohol and water, or a solution of chlorid of ammonium. These evaporating lotions produce cold. Instead of them, an ice-bag may be used for a day or two. Leeches around the joint do good. Constitutionally, employ the remedies for inflammation. Morphin or Dover's powder is given for the pain. Judicious bandaging limits the swelling.

After a day or two, if the symptoms continue or if they grow worse, use hot fomentations, the hot-water bag, plunge the extremity frequently in very hot water, or apply heat by Leiter's tubes. When the acute symptoms begin to subside, rub stimulating liniments upon the joint once or twice a day and employ firm compression by means of a bandage of flannel or rubber. Frictions should be made from the

periphery toward the body. Many cases do well at this stage under the local use of ichthyol and lanolin (50 per cent.), tincture of iodin, or blue ointment. Later in the case use hot and cold douches, massage, frictions, passive motion, and the bandage. Passive motion is begun a day or so after swelling ceases. If massage causes the swelling to return, abandon it for several days and then try it again. Blisters are used when tender spots persist and stiffness is manifest. If stiffness becomes marked, move the joint forcibly. Give iodid of potassium and tonics internally, and insist on open-air exercise. If the person is gouty or rheumatic, use appropriate remedies. Van Arsdale treats sprains by massage almost from the start. Gibney treats them by strapping with adhesive plaster. Many sprains may be put up in an immovable dressing the first day or two after the accident. If the joint contains much blood, aspiration should be practised before the dressing is applied.

The hot-air oven is a very valuable method for treating recent sprains, and the swelling, pain, and stiffness which follow sprains, of the extremities. The sprained extremity is placed in an oven, and the joint is subjected to heat for an hour. The next day the treatment is repeated, and on as many subsequent days as may be necessary. In an acute sprain the pain often disappears during the first application of heat. In the intervals between the use of the oven the extremity should be at rest upon a splint.

Ankylosis.—When a joint-inflammation eventuates in the formation of new tissue in and about the joint contraction of this tissue limits or destroys joint-mobility, producing the condition known as "ankylosis." Ankylosis may be complete (bony) or incomplete (fibrous); it may arise from contractures in the joint (true or intra-articular ankylosis) or from contractures in the structures external to the joint (false or extra-articular ankylosis).

True or intra-articular ankylosis may arise from any cause which produces joint-inflammation with formation of new tissue, and may be due to wounds, contusions, sprains, dislocations, fractures in or near a joint, movable bodies in a joint, tubercle, gout, rheumatism, or syphilis. Immobilization of a healthy joint may cause partial ankylosis, though this has been denied. Even a proper immobilization of a healthy joint will, if prolonged, cause muscular atrophy, but the weakness and stiffness will pass away entirely under the influence of proper treatment. Firm immobilization with pressure may produce disastrous results. Dr. O. W.

Phelps[1] points out that experiments made by himself in association with Dr. W. Gilman Thompson and Dr. J. C. Cardwell show that immobilization of a normal joint will not produce ankylosis in five months, and that when a healthy joint becomes ankylosed, it is due to some pathological cause. Improper immobilization may produce and maintain intra-articular pressure, and such pressure may destroy the head of the bone and the socket, and ankylosis will result. Further, Phelps shows that muscular atrophy is sure to follow prolonged immobilization. Ankylosis is more apt to take place in a hinge-joint than in a ball-and-socket joint. In ankylosis from a general cause (as rheumatic gout) many joints are apt to suffer. Ankylosis may be due to fibrous tissue, and is then usually partial; it may be due to chondrification of fibrous tissue, and is then incomplete; it may be due to ossification of fibrous tissue, and is then complete, the joint being entirely immobile (osseous or bony ankylosis). The entire joint may be converted into bone. Only one small joint-surface may contain adhesions (limited adhesions), or the entire joint-surface may be bound up in them (diffused adhesions). In what is known as spondylitis deformans there is bony ankylosis of the vertebræ. Arthritis ossificans is a progressive bony ankylosis in which numerous joints are involved, and are finally completely obliterated. It is essentially the same disease as spondylitis ossificans and is an ossifying arthritis.[2]

Fibrous ankylosis may follow aseptic inflammation; bony ankylosis is apt to follow infections. Though slight motion is usually possible in fibrous ankylosis, in some cases it may be impossible. A joint immovable from fibrous ankylosis is distinguished from a joint immovable from bony ankylosis by the fact that in the former attempts at motion are productive of pain, and subsequently of inflammation. The incapacity resulting from ankylosis is due, first, to the impairment or destruction of joint-function, and, secondly, to the fixation at an inconvenient angle (a fixed flexed knee is worse than a fixed extended knee; a fixed extended elbow is worse than a fixed partly flexed elbow).

Treatment.—The effort should always be made to prevent ankylosis by treating carefully any joint-inflammation and by beginning passive motion and massage at the proper time. To limit inflammation is to prevent ankylosis. An

[1] *Railway Surgeon*, July 26, 1898.

[2] See Dr. Joseph Griffith, in *Jour. of Pathology and Bacteriology*, for December, 1896, and March and June, 1897.

inflammatory exudate exists in and about the tendons and ligaments, and even in the joint. Early massage and gentle movements remove this exudate before it is organized, and if organization of the exudate does not occur, ankylosis will not follow the injury or disease. In an acutely inflamed joint, however, passive motions must not be made, the part is kept at rest until acute symptoms subside, but gentle massage can be used daily. When fibrous ankylosis arises it may be improved or cured by the use of the hot-air oven, passive motion, active movements, massage, frictions with stimulating liniments, inunctions of ichthyol or mercurial ointment, hot and cold douches, and electricity. Some cases may be straightened out slowly by screw-splints or by weights and pulleys. Fibrous ankylosis of the elbow is best treated by using the joint. Fibrous ankylosis is often corrected by forcible straightening. If the tendons are much contracted, tenotomy should be performed two or three days before forcible straightening is attempted. Before straightening forcibly always administer an anesthetic. Suppose a case of ankylosis of the knee: administer ether, put the patient upon his back, bring the leg over the end of the operating-table, grasp the ankle with one hand and the lower portion of the leg with the other hand, and make strong, steady movements of flexion and extension until the limb can be straightened. The adhesion will be felt to break, the snapping often being audible. At once apply a plaster-of-Paris dressing to the extended extremity, and keep the limb immobile for two weeks. At the end of this period remove the plaster and begin massage and passive movements, and, if reaction is not great, soon advise active movements. This procedure is not free from danger. Vessels may be ruptured, nerves may be torn, skin and fascia may be lacerated, suppuration may ensue from the admission into the joint of encapsuled cocci, or of organisms in the blood which find in this area a *point of least resistance*. Because of the danger of opening up dépôts of encapsuled bacilli and cocci, do not forcibly break up an ankylosis that results from a tubercular or a septic arthritis, but use gradual extension by weights or by screw-splints. Ankylosis of the knee following fracture of the patella is almost sure to recur after forcible breaking up. The best treatment for knee-ankylosis is use of the joint. In bony ankylosis of any joint other than the elbow-joint do nothing if the joint is in a useful position. If the joint is firmly fixed in an unfortunate position, resort to excision or an osteotomy. In the elbow

excision should be performed, no matter what the position, in the hope of obtaining a movable joint. In ankylosis of the jaw surgeons formerly endeavored to remedy the condition by wedging the jaws apart with a mouth-gag, and afterward inserting boxwood plugs at frequent intervals. This method is invariably a failure.[1] Esmarch's operation is sometimes curative (removal of a wedge-shaped piece of bone). Some operators excise the condyle and a portion of the neck. Swain advocates sawing the bone at the angle.

False or Extra-articular Ankylosis.—In this condition the joint is intact, but the contractures are in surrounding parts. The causes are muscular, fascial, and tendinous contractures, cicatrices (especially from burns), deposits of bone, muscular paralysis, tumors, and aneurysm. Contractions of muscles or tendons may be due to gout, rheumatism, injury, thecitis, fractures, and dislocations. False ankylosis is seen in club-foot and in Dupuytren's contraction.

Treatment.—The treatment of false ankylosis depends upon the cause. Recently contracted muscles or tendons require motion, massage, frictions with stimulating liniments, hot and cold douches, and the use of the hot-air apparatus. Old contractions require division. Whenever possible, excise a cicatrix that causes false ankylosis, and fill the gap with good tissue. Bony deposits are gouged away and tumors are removed. Contractures in cases of paralysis require electricity, passive motion, frictions with stimulating liniments, the hot-air bath, and general treatment.

Loose Bodies in Joints (Floating Cartilages).—The knee is the joint oftenest affected. These bodies may be free or each may have a stalk or pedicle; they may move about and occasionally block the joint, or may lie quietly in a joint-recess or diverticulum. They may be single or multiple, flat or ovoid, smooth or irregular, as small as peas or as large as plums, and may be composed of fibrous tissue, of bone, or of cartilage. There are numerous different modes of origin of these bodies, many being "detached ecchondroses or pieces of hyaline cartilage hanging by narrow pedicles" (J. Bland Sutton), and they result from enlargement and chondrification of the villi of the synovial membrane. Some loose bodies are broken-off osteophytes; some arise from blood-clots; some by projection or herniation of the synovial membrane, which protrusion is broken off; others are detached fringes of tubercular synovial membrane. Trauma-

[1] Swain, in *Lancet*, 1894, vol. ii. p. 187.

tism is the usual exciting cause. Loose cartilages are commonest in adult men.

Symptoms.—Many small bodies give rise to no symptoms other than those of synovitis. A large body produces pain and interferes with joint-function. The joint is weak and a little swollen, and the patient can feel the body and often can push it into a superficial area of the joint, where it may be felt by the surgeon. From time to time the body may get caught, thus suddenly locking the joint and producing intense and sickening pain, extension and flexion being impossible until the body slips out. This accident is followed by inflammation and effusion.

Treatment.—To relieve locking, employ forced flexion and sudden extension. Cure can be obtained only by operation. Asepticize with the utmost care. Let the patient bring the foreign body to a point where it can be felt; the surgeon then fixes it with a pin or holds it with the fingers, ether being given or cocain being used. The joint is now opened, the foreign body extracted, and an exploration made to see that no other bodies are present. The wound is sutured and the leg is placed upon a splint. Asepsis must be most rigid. The operation does not cure the causative lesion, and these bodies are apt to form again.

4. Luxations or Dislocations.

A dislocation is the persistent separation from each other, partially or completely, of two articular surfaces. A self-reduced dislocation is called a sprain (Douglas Graham). There are three forms of dislocations: (1) traumatic; (2) spontaneous or pathological; (3) congenital.

1. **Traumatic dislocations** are due to injury. They are divided into—*complete* dislocation, in which the two articular surfaces are entirely separated and the ligaments are torn; *incomplete* or *partial* dislocation, in which the two articular surfaces are not completely separated and the ligaments are rarely lacerated; *simple* dislocation, in which there is no wound leading from the surface to the articulation; *compound* dislocation, in which a wound leads from the surface to the joint; *complicated* dislocation, in which, besides the dislocation, there is a fracture, extensive damage of the soft parts, an opening which makes the case compound, or damage of a nerve or blood-vessel; *primitive* dislocation, in which the bones remain as originally displaced; *secondary* dislocation, in which the dislocated bone assumes a new

position; for instance, a subglenoid luxation of the humerus is primary, and it may become secondarily a subcoracoid luxation because of muscular contraction or attempts at reduction; *recent* dislocation, in which the displaced bone is not firmly fastened by tissue-changes in its new situation, and its old socket is not obliterated; *old* dislocation, in which the displaced bone is firmly fastened by tissue-changes in its new habitat, and the old socket is to a great extent obliterated (whether a dislocation is old or new depends on the state of the parts rather than on the time which has elapsed since the accident); *double* dislocation, in which corresponding bones on each side are dislocated; *single* dislocation, in which only one joint is dislocated; *unilateral* dislocation, in which one articulation of one bone is out of place; *bilateral* dislocation, in which symmetrical articulations are dislocated; and *relapsing* or *habitual* dislocation, which recurs constantly from slight force because of relaxed ligaments or lack of complete repair after the ligamentous rupture of a first dislocation.

2. **Spontaneous, Pathological, or Consecutive Dislocations.**—Spontaneous dislocation arises from such very slight force that the cause may not be identified, and it acts on a joint rendered lax by disease. It may arise in the course of chronic synovitis, during tubercular joint-disease, and during rheumatoid arthritis. In typhoid fever spontaneous dislocation is not uncommon. The hip-joint is most often the one attacked. The dislocation in typhoid follows a severe joint-inflammation, is usually upon the dorsum of the ilium, and is frequently not noticed until convalescence. If a typhoid dislocation is seen early, reduction is easily effected, but if seen late is impossible. The treatment for irreducible typhoid dislocation is the same as for any other irreducible dislocation. In Charcot's joint this form of dislocation constantly appears. This condition comes on in a few hours, during the progress of locomotor ataxia, and is without apparent reason. The knee, the shoulder, or some other joint becomes greatly swollen, fluid gathers in large amount, the ligaments relax, the joint is destroyed and becomes excessively mobile, but there is no pain, no fever, and no sign of inflammation (p. 537). In Charcot's joint apply a support.

3. **Congenital Dislocations.**—A congenital dislocation is due to a congenital joint-malformation which renders it impossible for the bone to maintain a normal position, or is due to external violence during the period of uterine gestation. Congenital dislocations should not be confounded

with dislocations produced during delivery. The hip is the joint most often involved. The shoulder suffers occasionally. Lannelongue maintains that congenital dislocation of the hip is due to atrophy of the muscles and of the acetabulum following spinal-cord disease. Verneuil thinks the dislocation is paralytic. Broca truly says that in view of the fact that the head of the bone is larger than the cavity in which it belongs, it is useless to attempt reduction by manipulation or extension. Hoffa and Lorenz have each devised an operation for this condition (p. 613). Congenital dislocation of the shoulder requires incision, possibly excision, or the paring down of the head to fit the glenoid cavity (Phelps).

Traumatic Dislocations.—In the succeeding pages the traumatic form of dislocations will be particularly considered.

The causes of traumatic dislocations are divided into *predisposing* and *exciting*.

Predisposing causes are (1) *Age*—dislocations are commonest in middle life, the usual lesion of the young being green-stick fracture, and that of the old being fracture. Dislocations of the radius are not uncommon in youth. (2) *Muscular development*—dislocations being commonest in those with powerful muscles. (3) *Sex*—males being more predisposed than females, because of their occupations and muscular strength. (4) *Occupation* predisposes as a cause according as it demands the employment of muscular force, as in the carrying of burdens. (5) *Nature of the joint*—ball-and-socket joints being more liable to luxation than are ginglymoid joints, because of their wide range of motion. (6) *Joint-disease* predisposes by relaxing the ligaments. (7) *Situation of the joint*—some joints being more exposed to injury than others.

Exciting causes are classified into (1) external violence and (2) muscular action. *External violence* may be *direct*, as when a blow upon one of the bones forces it directly away from the other; or it may be *indirect*, as when a blow at a distant part of a bone transmits force to its end and drives the bone out of its socket. *Muscular action* is a cause when sudden and violent muscular contraction occurs during the maintenance of a position of the joint which gives the muscles full sway, and throws the head of the bone against the weakest part of its retaining ligaments.

Pathological Conditions.—In a recent complete traumatic dislocation the ligaments are damaged, and may perhaps show extensive laceration, or may show only a

button-hole laceration through which a bone projects. External force produces much laceration and little stretching of the ligaments; muscular action produces little laceration and much stretching of the ligaments. In some cases of dislocation due to external violence the structures about the joint are bruised or otherwise damaged; the old socket is filled with blood, and the bone in its new situation lies in a bloody area. Large vessels and nerves are rarely torn, though they may be compressed.

If a dislocation is not soon reduced, inflammation arises in the old joint and about the displaced bone, and the whole area is glued together, first by coagulated exudate, and finally by fibrous tissue. After a time, in ball-and-socket joints, the old socket fills with fibrous tissue, contracts, becomes irregular, and may even be obliterated; the head of the dislocated bone is altered in shape, its cartilage is destoyed or converted into fibrous tissue, and the pressure of the head of the bone forms a hollow in its new situation, which hollow becomes surrounded by fibrous tissue or even by bone. A new joint may form, the surrounding tissue becoming a compact capsule, and a bursa forming between the head of the bone and its new socket. In a dislocated hinge-joint the ends of the bone alter greatly in shape and their cartilage is converted into fibrous tissue. In an unreduced dislocation the muscles shorten or lengthen or undergo atrophy or fatty degeneration, as the case may be. An unreduced dislocation of a ball-and-socket joint may give a fairly movable new joint, but an unreduced dislocation of a hinge-joint rarely allows of much motion.

General Symptoms of Traumatic Dislocations.—In general, traumatic dislocations are indicated (1) by *pain* of a sickening, nauseating character; (2) by *rigidity*, voluntary motion being impossible except to a slight extent in the direction of the deformity. (For instance, in dislocation of the inferior maxillary the jaw can be opened a little more, but it cannot be closed.) This rigidity brings about loss of function. When the surgeon attempts to move the joint he finds it very rigid; (3) by *change in the shape of the joint* (as flattening of the shoulder after dislocation of the humerus); (4) by *alteration in the mutual relations of bony prominences about a joint* (as the alteration of the relation between the olecranon and humeral condyles in dislocation of the elbow backward); (5) by feeling the displaced bone in its new situation; (6) by missing the head of the bone from its proper situation; (7) by alteration in the length of the limb

(in dislocation of the femur into the thyroid foramen the limb is lengthened, but in dislocation onto the dorsum of the ilium it is shortened); and (8) by alteration in the axis of the bone (in dislocation upon the dorsum of the ilium the axis of the injured thigh would, if prolonged, pass through the lower third of the sound thigh); (9) by seeing the dislocation with a fluoroscope or looking at a skiagraph of it.

Diagnosis of Traumatic Dislocations.—A dislocation may be mistaken for a fracture. In dislocation there is rigidity, in fracture there is preternatural mobility; in dislocation there is no true crepitus (may get tendon- or joint-crepitus), in fracture there usually is crepitus; in dislocation the deformity does not tend to recur after reduction, in fracture it does recur after extension is relaxed. In a sprain the movements of the joint are only limited, not abolished, by an almost complete rigidity. The change which a sprain may cause in the shape of a joint is due to effusion or to bleeding; there is no alteration in the relation of the bony prominences to one another; there is no notable alteration in the length of the limb (a slight increase in length may arise from joint-effusion, or the head of the bone may subsequently be absorbed, and thus produce shortening after some weeks); there is no alteration in the axis of the bone; the head is not felt in a new position, it being found in its normal place. Always remember that a fracture may exist with a dislocation. In any doubtful case—in fact, in most cases—give ether, for a dislocation should be reduced while the patient is anesthetized (except in dislocation of the jaw, of the fingers, of the carpus, etc.). In some cases swelling renders the diagnosis difficult or impossible. Always compare the injured joint with the corresponding joint of the sound side. The x-rays constitute a valuable aid to diagnosis.

Treatment of Traumatic Dislocations.—*Recent Simple Dislocations.*—Reduce simple dislocations under ether, as a rule. Try *manipulation*, a procedure which seeks to make the bone retrace its own pathway. If this procedure fails, employ extension and counter-extension. If considerable force is needed, an assistant makes counter-extension, and the surgeon fastens to the extremity a clove-hitch, which he ties about his waist, and thus secures powerful extension. Counter-extension may be obtained by bands, or, in some instances, by the foot of the surgeon. The clove-hitch is used because it will not tighten by traction, a tightening band would lacerate the soft parts (Fig. 178).

If great power is needed, compound pulleys may be employed, such as the Jarvis adjuster or some similar appliance, but at the present day pulleys are rarely used (see page 554). If these means fail, cut down upon the bone and restore it to position; operation is much safer than is the application of great force. After reducing a dislocation, immobilize the joint for a time, which varies for different joints, and for the first few days combat swelling and inflammation by rest of the part and the use of evaporating lotions or an ice-bag. If there exists a fracture of the dislocated bone, apply splints and then try to reduce by manipulations, grasping the limb and the splints with one hand below and, if possible, with the other hand above the seat of the fracture. Allis believes that a dislocation can be reduced even when a fracture exists. It is possible to pull the dislocated head down to the joint, because a portion of periosteum and possibly tendinous material and muscle still hold the two fragments as a strap might unite two sticks. The head can be forced into place by the fingers while traction is being made. If the fracture is near the joint and the fragments cannot be fixed, try to reduce the dislocation, first striving to press the bone into place. This attempt can be greatly aided by traction upon the lower fragment. In some cases with fracture reduction can be much aided by making a small incision, screwing a gimlet into the head of the bone, and using this tool as a handle. McBurney incises, drills a hole in each bone, inserts hooks into them, and pulls the dislocated bone into position (Figs. 112, 113). When the dislocation has been reduced the bone fragments are wired.

Compound Traumatic Dislocations.—The opening in the soft parts may be due to external violence or to projection of a bone. Compound dislocations are very serious. Hinge-joints are more liable to these injuries than are ball-and-socket joints. Many cases require excision, some amputation; one that does not demand excision or amputation should be treated by sterilizing the parts, restoring the dislocated bone, making a counter-opening, draining, dressing antiseptically, and immobilizing. Considerable ankylosis generally ensues, except sometimes in the small joints. It is scarcely ever necessary to cut away any portion of the protruding bone to effect reduction. If a joint is badly splintered, or if the soft parts are extensively damaged, excise or amputate; if the main vessels or the nerves are seriously injured, or if the patient is so old or so feeble that it is perilous to force him to combat a long illness, amputate.

Old Traumatic Dislocations.—The problem always presented in an old dislocation is, Shall reduction be tried, or shall the bones be left alone? Sir Astley Cooper laid down this rule: "Do not attempt to reduce a shoulder-dislocation after three months, nor a hip-dislocation after two months;" but this rule was laid down before the days of ether. Do not select any fixed period of time to determine what action is advisable. In dislocation of a ball-and-socket joint considerable motion may become possible and a new joint may form. If movement does not produce pain, a useful new joint may be obtained by the persistent employment of active and passive movements; if movement of the limb does produce pain, enough motion will not be attempted by the patient to produce a useful joint. In the former case try to obtain a useful new joint, and in the latter case try to reduce the old dislocation.

In trying to reduce an old dislocation, give ether, make movement to break up adhesions, and persist in making these motions until the head of the bone is felt to move; then try at once to reduce by manipulation or extension, and counter-extension, not waiting for two days, as some suggest. If the head of the bone cannot be made to move, the Dieffenbach plan may be followed, which is to cut the tense restraining bands with a tenotome. Always remember that dislocations of a hinge-joint, if left unreduced, will never eventuate in a useful artificial joint. Lord Lister, being much impressed with the danger inevitably linked with forcibly dragging old dislocations into place, prefers to cut down and restore the bone, employing, of course, the strictest asepsis, and surgeons in general have adopted this view. In some old dislocations excision of the head of the bone is the proper operation.

Special Traumatic Dislocations.—Lower Jaw.—A dislocation of the lower jaw, when there is no fracture, is almost invariably forward. Backward dislocation without fracture is extremely rare, and some have maintained that it cannot occur. Croker King reported a case in 1858. Theim has observed it seven times in five women. The condyle passes under the lower surface of the auditory canal.[1] The common dislocation is forward, and this is the form meant when we simply speak of dislocation of the jaw. There are two forms of forward dislocation—the *unilateral*, which is rare, and the *bilateral*, which is common. Dislocations of the jaw are commonest in women and during middle life. When the

[1] Theim, in *Rev. de Chir.*, vol. 8, 1888.

mouth is open contraction of the external pterygoid may pull the condyle over the articular eminence; this contraction may be brought about by yawning, vomiting, scolding, etc. When the mouth is open dislocation of the lower jaw may be caused by a blow upon the chin; it may also be caused by forcing the mouth more widely open by pushing a bulky body between the teeth.

Symptoms of Lower-jaw Dislocations.—In the *bilateral* form the mouth is open and fixed, and it cannot be closed, though it can be opened a little more. The condyles are in front of the articular eminences, and are fixed by the action of the masseters and internal pterygoids, the coronoid processes being wedged against the malar bones. The lower jaw is advanced in front of the upper and the face looks longer than natural. The lips cannot close, the saliva dribbles, swallowing and speech are difficult, there is a depression in front of each ear, the condyles are recognizable in their new abodes, the coronoid processes are detected by a finger in the mouth, and the masseters and temporals stand out in a state of rigidity. Pain may be severe or be absent. In the *unilateral* form the chin goes toward the sound side, and the mouth is not so widely open as in the bilateral form, neither is the jaw so fixed. The symptoms are similar to those of a bilateral luxation, but are not so pronounced. The hollow in front of the ear and the condyle in an abnormal situation are only detected upon one side. In an unreduced dislocation the patient may after a time establish some movement of the jaw, but the power of mastication will always be impaired seriously.

Treatment of Lower-jaw Dislocations.—In treating dislocations of the lower jaw the patient is placed with his head against the back of a chair or against the body of an assistant. The surgeon, after wrapping up his thumbs to protect them from being bitten, stands in front of the patient, puts his thumbs upon the last molar teeth, and grasps the chin with his free fingers. He now presses downward and backward on the jaw, and as soon as the condyle is loosened closes the jaw over the thumbs by pushing up the chin, using his thumbs as levers. If this procedure fails, wedges should be put between the molar teeth and the chin should be pushed up either by the hands or by a tourniquet whose band is round the head and chin. In a unilateral dislocation the wedge should only be used on the injured side. In difficult cases Sir Astley Cooper pushed a round wooden ruler between the molar teeth, used the upper teeth as a

fulcrum, and raised the end of the ruler as the handle of a lever. The forceps used by an anesthetizer may depress the condyle from its point of fixation, whereupon the chin may be pushed up and back. Nélaton's plan was to put the thumbs in the mouth and push the coronoid processes backward. In an old dislocation always try reduction, at least up to a period of six or seven months. After reduction apply a Barton bandage for over two weeks, taking it off once a day, and begin passive motion in the second week; discard the bandage in the third week. Liquid diet is advisable for three weeks after the accident. An unreducible dislocation requires osteotomy of the neck of the bone, if the part cannot be restored after incision.

Dislocation of the Clavicle.—Sternal End.—There are three forms of dislocation of the sternal end of the clavicle, namely: (1) forward; (2) backward; and (3) upward.

Forward Dislocation of the Sternal End of the Clavicle.—The *causes* of forward dislocation of the clavicle are blows, falls, or pulls which drive or draw the shoulder backward.

Symptoms and Treatment of Forward Dislocation of the Clavicle.—The symptoms manifest in dislocation of the clavicle are—prominence in front of the sternum; the acromion is nearer to the sternum on the injured than on the sound side; the clavicular origin of the sternocleidomastoid is rigid; movement is difficult and painful. To treat a dislocation of the clavicle, pull the shoulders back against the knee of the surgeon, which is placed between the scapulæ. Dress with a posterior figure-of-8 bandage (Fig. 362), or a Velpeau bandage (Fig. 364), the dressing to be worn for three weeks. After removal of the dressing apply a truss, the pad of which is put over the head of the clavicle, and which instrument is to be worn for a month. Dislocation of the clavicle is difficult to keep reduced, but even if it becomes fixed in deformity the motions of the arm will not be impaired permanently. It can be reduced and fixed by incision and wiring.

Backward dislocation of the sternal end of the clavicle is very rare. The *causes* are direct violence and indirect force, such as falls or blows which drive the shoulder forward and inward.

Symptoms and Treatment of Backward Dislocation of the Clavicle.—The symptoms are—pain; loss of function in the arm; inclination of head toward the injured side; stiffness of the neck; the shoulder passes forward and inward, and often falls downward; a depression exists over the sternoclavicular

joint; the head of the clavicle cannot be felt, or is found back of the sternum. The displaced clavicle may press upon the trachea, the esophagus, or the great vessels, inducing dyspnea, dysphagia, obliteration of pulse in the arm of the injured side, or great venous congestion of the head (see Pick). To treat a backward dislocation, pull the shoulders backward and apply a posterior figure-of-8 bandage (Fig. 362), which must be worn for three weeks. If pressure-symptoms are urgent, resect the displaced head.

Upward dislocation of a clavicle is very rare. The *cause* is indirect force which carries the shoulder downward, inward, and backward (Smith).

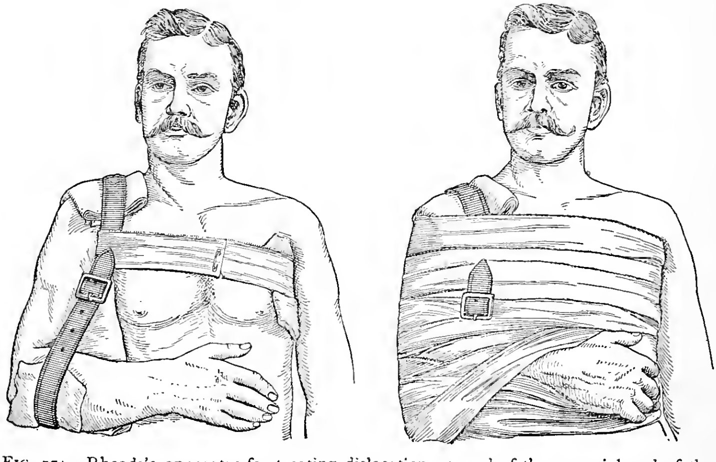


FIG. 174.—Rhoads's apparatus for treating dislocation upward of the acromial end of the clavicle.

Symptoms and Treatment of Upward Dislocation of the Sternal End of the Clavicle.—The chief symptom is impaired function of the arm; the shoulder passes downward and inward, the clavicular axis is altered, and the displaced head is felt. Dyspnea may or may not exist. To treat this dislocation, put a pad in the axilla and press the elbow to the side in order to throw the bone outward, and try to push the head into place. Apply a Desault bandage (Fig. 367) and place a firm pad over the sternoclavicular joint. The deformity is apt to recur, but a useful limb will nevertheless be obtained. It may be desirable to wire the bones in place.

Dislocation of the acromial end of the clavicle is almost always upward, but it may be below the acromion. The *cause*

is violent force, which, if so applied to the scapula as to drive the shoulder forward, may produce a dislocation upward. A dislocation downward is due to blows upon the upper surface of the outer end of the clavicle.

Symptoms and Treatment.—The symptoms of dislocation of the acromial end of the clavicle are—prominence of the clavicle upon the top of the acromion; impaired function of the arm (it cannot be lifted over the head); the shoulder falls downward and passes inward; there is apparent lengthening of the arm; the head is bent toward the injured side, and the clavicular origin of the trapezius is strongly outlined (Pick). In dislocation downward both the acromion and the coracoid are very prominent, the clavicular axis is altered, and there is depression over the sternoclavicular joint. A dislocation upward is reduced by pulling the shoulder back and pushing the bone into place. The old method was to apply a Desault bandage, which was kept on for three weeks, and more or less deformity was looked for as inevitable. Stimson dresses with adhesive plaster. The author has recently seen a case treated by the apparatus of Thomas Leidy Rhoads. The apparatus completely corrected the deformity, and the patient made a most satisfactory recovery. The essential element of Rhoads's apparatus is a trunk strap applied as is shown in Fig. 174. Dislocation downward is reduced and treated in the same manner as dislocation upward.

The so-called **dislocation of the lower angle of the scapula** is not, as it was long thought to be, a dislocation at all. The lower angle and vertebral border deviate from the chest. This condition was thought to be due to the bone slipping from under the latissimus dorsi muscle, but it is now known to be due to paralysis of the serratus magnus muscle, the bone being acted upon by the trapezius, pectoralis minor, levator anguli scapulæ, and rhomboid muscles. Examination shows that the scapula will not rotate normally forward. This is demonstrated by extending the arms in front to a right angle, the gliding forward of the scapula upon the sound side being marked and upon the diseased side being slight or absent.

Treatment of dislocation of the lower angle of the scapula comprises massage, electricity, passive motion, and deep injections of strychnin.

Simultaneous dislocation of both ends of the clavicle is a very rare injury. It is treated as is single dislocation.

Dislocations of the Humerus (Shoulder-joint).—These injuries are quite frequent because of the free mobility of the

shoulder-joint, its anatomical insecurity, and its exposed situation; they rarely occur in the very young and in the aged, and are oftenest encountered in muscular young adults. Four chief forms of shoulder-joint dislocation exist, namely: (1) forward, inward, and downward, under the coracoid process—subcoracoid; (2) downward, forward, and inward, beneath the glenoid cavity—subglenoid; (3) backward, inward, and downward, under the spine of the scapula—subspinous; and (4) forward, inward, and upward, under the clavicle—subclavicular.

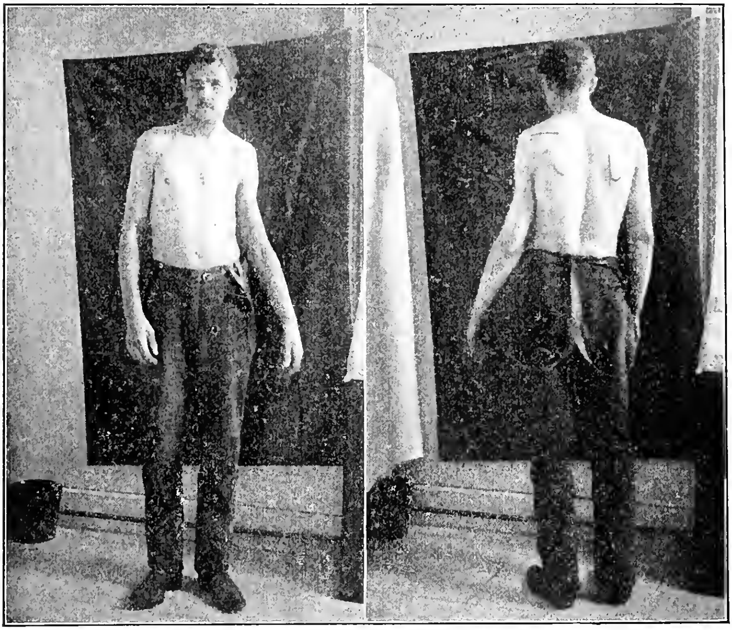


Fig. 175.—Subcoracoid dislocation of the humerus (St. Joseph's Hospital case; photographed by Dr. Nassau).

A very rare form of shoulder-joint dislocation has been described, which is known as the "supracoracoid." Another rare form is the luxatio erecta.

Subcoracoid Luxation.—The subcoracoid variety of dislocation embraces three-fourths of all the shoulder-joint luxations. It may be caused by direct force driving the head of the humerus forward and inward, or by indirect force, such as falls upon the hand or the elbow. In this dislocation the anatomical neck of the humerus lies upon the anterior margin of the glenoid cavity, just beneath

the coracoid process, and is above the tendon of the subscapularis muscle.

Subglenoid or *axillary luxation* may be produced by contraction of the great pectoral and latissimus dorsi muscles when the arm is at a right angle to the body, but it is usually due to falls upon the hand or the elbow when the arm is raised and the head of the bone is against the lower portion of the capsule. In this dislocation the head of the bone rests upon the border of the scapula, below the tendon of the subscapularis, in front of the long head of the triceps, and above the teres muscles. Some observers hold that most dislocations of the shoulder are primarily subglenoid, the position having been altered by muscular action.

Subspinous luxation is a rare injury. Pick met with this accident in a man who, while having his hands in his pockets, fell upon the front of the point of the shoulder. The head of the bone reposes beneath the scapular spine, between the infraspinatus and teres minor muscles.

Subclavicular luxation is very rare. It is caused by the same sort of violence which produces subcoracoid luxation. The head of the bone rests upon the thorax, below the clavicle and underneath the pectoralis major muscle.

In the rare form known as the "supracoracoid" the head of the humerus rests upon the coraco-acromial ligament or upon the acromion process and the acromion or the coracoid is always fractured.

Luxatio erecta is an unusual form of subglenoid dislocation. The arm is upright and the forearm rests behind the occiput or on the top of the head, and the patient holds it there to avoid pain. Judd, Hulke, and Cleland have related cases.

Symptoms of Dislocation of the Shoulder-joint.—Dislocation is diagnosticated by (1) pain of a sickening character; (2) flattening of the shoulder, the head of the bone having ceased to bulge out the deltoid muscle; (3) apparent projection of the acromion through sinking in of the deltoid; (4) hollow beneath the acromion, over the empty glenoid cavity, and the bone missed from its normal habitat. This hollow may be easily appreciated by the finger, especially when the extremity is somewhat abducted; (5) rigidity (some movement is possible, in the direction especially of an existing deformity, but mobility is strictly limited and attempts at motion produce great pain); (6) the elbow cannot touch the side when the hand is placed upon the sound shoulder, and the hand cannot be placed upon the sound shoulder if the elbow is to the side—Dugas's sign (this is due to the rotundity of the

chest. In a dislocation the head of the bone is already touching the chest, and the bone, being approximately straight, cannot touch it in two places at the same time. If the elbow can be placed against the chest with the hand on the sound shoulder, there cannot be dislocation; if it cannot be so placed, there must be dislocation); (7) finding the head of the bone in a new situation; (8) examining by means of the X-rays. Symptoms 1 to 5 inclusive may be grouped as Erichsen's list of signs. The form of dislocation is made out by a study of the direction of the axis of the limb, the existence and extent of lengthening or of shortening, and the situation of the head of the bone.

The following table from T. Pickering Pick's work on *Fractures and Dislocations* makes the above points clear:

	Direction of the Axis of the Limb.	Alteration in the Length of the Limb.	Presence of the Head of the Bone in New Situation.
Subcoracoid.	The elbow is carried backward and slightly away from the side.	Very slight lengthening.	The head of the bone cannot easily be felt; if it can, it is found at the upper and inner part of the axilla.
Subglenoid.	The elbow is carried away from the trunk and slightly backward.	Very considerable lengthening.	The head of the bone can easily be felt in the axilla.
Subspinous.	The elbow is raised from the side and carried forward.	Lengthening intermediate in degree between the subglenoid and the subcoracoid.	The head of the bone can be felt and be grasped beneath the spine of the scapula.
Subclavicular.	The elbow is carried outward and backward.	Shortening.	The head of the bone can readily be seen and be felt beneath the clavicle.

In a shoulder-joint dislocation the head of the bone may press upon the brachial plexus and produce pain and numbness, and occasionally a traumatic neuritis or paralysis; sometimes pressure upon the axillary vein causes intense edema, and pressure upon the axillary artery diminishes or obliterates the pulse. The axillary vessels may be torn and the muscles may be lacerated badly. The capsule is torn and considerable blood is usually effused. Swelling is due first to hemorrhage, and secondly to inflammation. Partial dislocations sometimes, though rarely, occur. What is usually spoken of as "partial dislocation" or "subluxation" is a condition in which the head of the humerus passes forward

under the coracoid because of rupture of the long head of the biceps or because this tendon slips out of its groove, the ligaments being intact.

Diagnosis of Shoulder-joint Dislocation.—In fracture of the neck of the scapula there is prominence of the acromion and a hollow below it, a hard body being felt in the axilla; but the coracoid process descends with the head of the bone, which it does not do in dislocation. Furthermore, in fracture there is mobility; in dislocation rigidity. In fracture crepitus is present; in dislocation it is absent. In fracture the deformity is easily reduced, but it at once recurs; in dislocation the deformity is with difficulty reduced, but does not recur. In fracture the elbow can be made to touch the side when the hand is upon the sound shoulder; in dislocation it cannot be so manipulated. In fracture of the anatomical neck of the humerus deformity is slight; the head of the humerus is found in place, and does not move when the shaft is rotated; and the head is not in line with the axis of the bone. Crepitus exists in fracture if impaction is absent. In paralysis of the deltoid there is distinct flattening, but the bone is felt in place and there is no rigidity. The *X*-rays are a great aid to diagnosis.

Treatment of Shoulder-joint Dislocation.—Reduction by manipulation is usually readily obtained in recent cases of shoulder-joint dislocation. It is usually well to give ether. Forward dislocations (subcoracoid, subclavicular, and axillary) are reduced by Kocher's method (Fig. 176): Put the arm

FIG. 176.—Kocher's method of reduction by manipulation: *a*, first movement, outward rotation; *b*, second movement, elevation of elbow; *c*, third movement, inward rotation and lowering of the elbow (Ceppi).

against the side, flex the forearm to a right angle with the arm, perform external rotation of the arm until resistance becomes decided, raise the elbow, make internal rotation, bring the arm across the front of the chest and lower the elbow. The formula is, flexion of the forearm, external rotation, lift-

ing elbow forward, internal rotation of the arm, and lowering the elbow. If in trying Kocher's plan external rotation of the humerus does not take place, abandon the method, as persistence will fracture the humerus. Another method of manipulation is as follows: if the *right* shoulder is dislocated, the surgeon stands behind the patient (who is sitting erect); if the *left* shoulder is dislocated, he stands in front of the patient. The surgeon holds the forearm flexed upon the arm with his right hand and makes external traction and rotation, and with the fingers of his left hand he tries to force the bone into place.

In Henry H. Smith's method for forward dislocations the surgeon stands in front of the patient. If the *left* shoulder is dislocated, the surgeon grasps it with his left hand; if the *right* shoulder is dislocated, he grasps it with his right hand, the thumb resting on the head of the bone. With his disengaged hand the surgeon grasps the elbow, abducts it, makes traction and external rotation, and suddenly sweeps the elbow inward, aiming it at the sternum, and tries with his thumb to push the bone into place. In subspinous luxations reduction may be effected if the surgeon stands behind the patient, makes abduction, traction, and internal rotation, sweeps the elbow inward toward the spine, and with the thumb aids the bone in its return into position. Raising the elbow far above the head and sweeping it inward will reduce some dislocations. As the head of the bone slips back a distinct jar is felt and a snap is heard, the motions of the joint are again obtainable, and with the hand on the opposite shoulder the elbow may be made to touch the side.

Reduction by Extension.—In reduction of shoulder-joint dislocation by extension the patient is anesthetized and placed upon a low bed or upon the floor. The surgeon then places his foot, covered only by a stocking, in the axilla. Place the sole of the foot, not the heel, against the chest high up, the instep being made to touch the humerus and the heel the border of the shoulder-blade, a towel being first put into the axilla to rest the foot against (Fig. 177). If the left arm is dislocated, use the left foot, and *vice versâ*. The elder Gross approved of making extension while sitting between the patient's limbs. Make steady extension, which will in many cases bring about the reduction. If it fails to cause reduction, bring the patient's arm across the chest and use the foot as the fulcrum of a lever. If the humerus is pretty firmly fixed in its abnormal position, make counter-extension with a foot in the axilla and make extension by fixing a clove-

hitch (Fig. 178) *above the elbow* and fastening to it bands which go over one shoulder and under the other shoulder of the surgeon. The back may be used for extension, the hands being left free for manipulation (Allis's and Pick's plan).

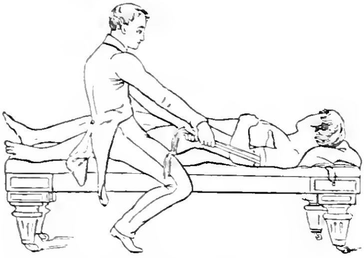


FIG. 177.—Reduction of shoulder-joint dislocation by the foot in the axilla (Cooper).

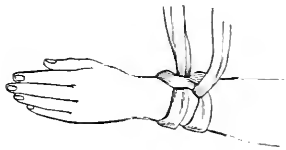


FIG. 178.—Clove-hitch knot applied above the wrist. In dislocation of the shoulder this knot is put above the elbow (after Erichsen).

Lateral extension is used by some surgeons. The patient lies down, a large piece of canvas is split, the arm is passed through the split and the body is thus fixed. The arm is pulled to a right angle with the body and traction is applied.

The late Prof. Joseph Pancoast favored Sir Astley Cooper's method of placing the unanesthetized patient in a chair and using the knee as a fulcrum, pushing the elbow to the side (Fig. 179). Brunus, in the thirteenth century, devised the method of *upward extension.* In applying this method

FIG. 179.—Reduction of shoulder-joint dislocation by the knee in the axilla (Cooper).

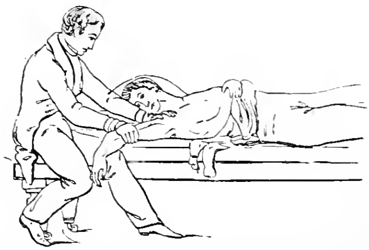


FIG. 180.—Reduction of shoulder-joint dislocation by upward extension (Cooper).

the surgeon takes his place behind the patient, steadies the scapula with his hand, and carries the patient's arm upward and backward above his head, making extension and external rotation (Fig. 180). La Mothe's method is applied with the patient supine upon the floor. The surgeon places his foot

upon the shoulder to make counter-extension, and makes extension as in Brunus's method. It is a useful expedient, when either of these plans is applied, to have an assistant make the traction while the surgeon manipulates the head of the bone. Cock advises, when reduction fails, that an air-pad be placed in the axilla and the arm be bound to the side—a method by which reduction will often take place after two or three days. The pulleys should not be used, as they develop a dangerous force, antiseptic incision being a safer and a better expedient. After incision try to restore the bone to place. In an old dislocation it may be necessary to resect the head of the bone.

In reducing a dislocation the axillary artery or vein may be ruptured, fracture of the neck of the humerus may take place, injury to the brachial artery may occur, or the soft parts may be badly damaged. After reducing a dislocation apply a Velpeau bandage, keep the shoulder immobile for one week, then make passive motion daily, reapplying the dressing after each seance. The patient may wear a sling alone during the third week, after which period he may use the arm. (For old dislocations and compound dislocations see pages 552, 553). Reduction of old dislocations may sometimes be effected by manipulation. Extension may have to be used, and ether may be required. In old dislocations try to reduce, after breaking up adhesions, by forced flexion and strong extension. After reduction immobilize for three weeks, and begin passive motion after seven days.

If a dislocation is complicated by a fracture of the humerus, try to pull the head of the bone opposite the joint. This may be possible if the two fragments are held partly together by a fair amount of periosteum and muscle. Traction is made upon the arm, and an attempt is made to manipulate the head into the socket (Allis's plan in the hip). McBurney incises, fixes a hook in the scapula and a hook in the head of the humerus, pulls the head into place, and wires the fragments (Figs. 111, 112, 113). In an emergency gimlets may be used instead of the hooks. In some cases it is necessary to excise the head of the bone.

Dislocations of the Elbow-joint.—Injuries of the elbow-joint are not rare, and they are commonest in children. Both bones or only one bone may be dislocated, and the dislocation may be partial or complete.

Dislocation of Both Bones Backward.—The *causes* of backward dislocation of both bones of the forearm are falls upon the extended hand or twists inward of the ulna

(Malgaigne). The coronoid process lodges in the olecranon fossa of the humerus.

Symptoms of Backward Dislocation.—In complete dislocation of both bones of the forearm the olecranon is very prominent; the distance between the point of the olecranon and the apex of the inner condyle is notably greater than on the sound side; the forearm is flexed, supinated, and shortened; the lower end of the humerus projects in front of the joint, below the skin-crease; the head of the radius is found back of the outer condyle; and there are the general symptoms of dislocation. Fracture of the coronoid rarely occurs with backward dislocation, but if it does occur there will be crepitus and mobility. Fracture at the base of the condyles is distinguished from dislocation of both bones of the forearm backward by the following points: in fracture there are found the ordinary symptoms; measurement from the condyles to the styloid processes does not show shortening; there is no alteration of the normal relation between the olecranon process and the condyles; and the projection in front of the joint is above the crease of the bend of the elbow.

Treatment of Backward Dislocation.—Reduction must be effected early in dislocation of both bones of the forearm, or it will be found impossible, and an unreduced dislocation means a limb without the powers of flexion, pronation, and supination. The surgeon places his knee in front of the elbow-joint, grasps the patient's wrist, presses upon the radius and ulna with his knee, and bends the forearm with considerable force, the muscles pulling the bones into place (Sir Astley Cooper's plan). Forced flexion, traction, and extension may be tried (Fig. 181). Put the arm in Jones's position for two weeks, and make passive motion daily after the first few days.

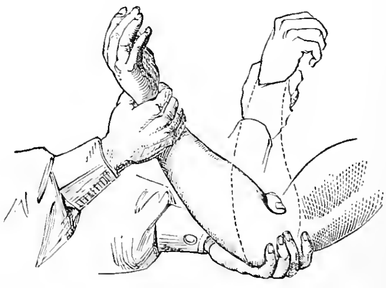


Fig. 181.—Reduction of elbow-joint dislocation.

Dislocation of Both Bones Forward.—The *cause* of forward dislocation of both bones of the forearm is a blow on the olecranon when the arm is flexed. It is a rare accident.

Symptoms and Treatment.—The symptoms of forward dislocation of both bones of the forearm are—forearm

is flexed and lengthened; some slight motion is possible; olecranon is on a level with the condyles if unfractured, hence its prominence is gone; the humeral condyles are felt posteriorly, and the radius and ulna are felt anteriorly. The *treatment* of this injury consists in early reduction, which is accomplished by means of forced flexion and pressure, placing the part in Jones's position for two weeks, and making passive motion daily after the first few days.

Lateral dislocations of both bones of the forearm are usually incomplete.

Symptoms and Treatment of Outward Dislocation.—The symptoms of outward dislocation of both bones of the forearm are—forearm is flexed, fixed, and pronated; joint is widened; the head of the radius projects externally and has a depression above it; the inner condyle projects internally and has a depression below it; the olecranon is nearer than normal to the external condyle and further than normal from the internal condyle. Reduction is effected by extension of the forearm and pressure inward upon the head of the radius. Apply an ascending spiral reverse bandage of the forearm, a figure-of-8 bandage of the elbow-joint, and a sling. Make passive motion after a few days. The bandages must be worn for two weeks.

Symptoms and Treatment of Inward Dislocation.—In dislocation inward of both bones of the forearm the position of the forearm is the same as that in dislocation outward; the sigmoid cavity of the ulna projects internally, and the external condyle projects externally. Reduction is effected by extension of the forearm and pressure outward on the ulna, subsequent treatment being the same as that employed in the preceding form.

Dislocation of the ulna alone is very rare, and can only take place backward.

Symptoms and Treatment.—Dislocation of the ulna alone is indicated by the forearm being flexed and pronated. The head of the radius is found in place, and the olecranon projects posteriorly. The *treatment* of this injury is the same as that for dislocation of both bones.

Dislocation of the Radius Forward.—Dislocation of the radius forward is the commonest form of dislocation of the elbow. This injury is caused by a fall upon the hand with the forearm in pronation and extension, or is produced by blows on the back of the joint; forced pronation alone will not cause it.

Symptoms and Treatment.—The symptoms in dislocation

of the radius forward are—forearm midway between pronation and supination, and semiflexed; attempts to increase flexion cause the radius to strike against the humerus with a distinct blow; the head of the radius is felt in front of the outer condyle and is missed from its proper abode. Reduction is effected by flexion over the knee, extension, and manipulation. Subsequent treatment is Jones's position and passive motion. Deformity is apt to recur after reduction, because of rupture of the orbicular ligament.

Dislocation of the radius backward is caused by falls on the hand or by blows on the front of the joint.

Symptoms and Treatment.—Backward dislocation of the radius is indicated by the forearm being slightly flexed and fixed in pronation, by some impairment of flexion and extension, and by the radius being felt behind the outer condyle. Reduction is effected by flexion over the knee, extension, and manipulation, and the subsequent treatment is the same as that given for the preceding dislocation.

Dislocation of the radius outward is very rare. In this injury the head of the radius is distinctly felt. Reduction is effected by extension and pressure; the subsequent treatment is the same as that for the above-mentioned dislocations.

Subluxation of the Head of the Radius.—This name is given to an injury which is very frequent in children between two and four years of age. It results from traction upon the hand or the forearm, and often arises when the nurse or the mother pulls upon a child's arm to save it from a fall or to lift it over a gutter. Some writers hold that pronation is required, as well as extension, to produce the injury; many surgeons claim that extension and adduction are the causative forces. Hutchinson maintains that supination may cause subluxation. Bardenheuer assigned falls as causes.

The *symptoms* are very characteristic. The history points to the injury. Pain, and often a click, may be felt in the wrist at the time of the accident. The arm hangs by the side, with the elbow-joint slightly flexed and the forearm midway between pronation and supination. Flexion to a less angle than 60° and complete extension are resisted and are very painful, but movements between 60° and 130° are free and painless.[1] The movements of the wrist-joint are free and painless. The elbow-joint presents no deformity. Pressure over the head of the radius causes pain. Strong

[1] See the instructive article by W. W. Van Arsdale, in the *Annals of Surgery*, vol. ix., 1889.

pronation is painful; strong supination is very painful, and there seems to be a mechanical obstacle to its performance. Forced supination develops a distinct click at the head of the radius, and causes pronation and supination to become natural and free from pain. The condition will be reproduced if a splint is not used. The nature of the lesion is not understood, and various conditions have been thought to exist by different observers. Among them may be mentioned the following: a slight anterior displacement of the head of the radius; a slight posterior displacement; locking of the tuberosity of the radius behind the inner edge of the ulna; dislocation of the triangular cartilage of the wrist; intracapsular fracture of the radial head; painful paralysis from nerve-injury; displacement by elongation, the return of the bone being prevented by collapse of the capsule; and the slipping up of the margin of the orbicular ligament over the rim of the head of the radius.

Treatment.—Place the forearm at a right angle to the arm and make forcible supination; apply an anterior angular splint, and have it worn for four or five days, or put the part in Jones's position for an equal period.

Dislocations of the wrist, which are very rare, are caused by falls upon the hand.

Backward Dislocation of the Wrist.—*Symptoms.*—The deformity in backward dislocation of the wrist (Fig. 182, A) resembles that of Colles's fracture (Fig. 182, B). The fingers are flexed, the wrist is bent backward, the radius projects

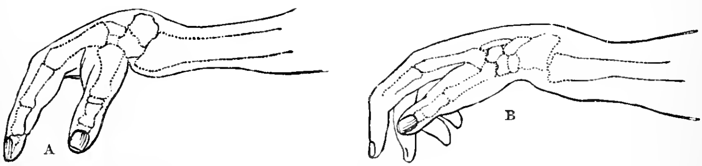


FIG. 182.—Deformity in dislocation of the wrist backward (A) and in Colles's fracture (B) (Stimson).

on the front of the wrist, the carpus projects on the dorsal surface of the forearm, the relation of the styloid process of the radius to the styloid process of the ulna is unaltered (it is altered in Colles's fracture), there is rigidity, and crepitus is absent (Fig. 182).

Forward dislocation of the wrist, which is very unusual, is caused by a fall upon the back of the hand.

Symptoms and Treatment.—In forward dislocation of the wrist the radius and ulna project posteriorly and the carpus

projects in front. The *treatment* in both of these dislocations is reduction by extension and manipulation, the use of a Bond splint for ten days, and the employment of passive motion after five or six days.

Dislocation at the inferior radio-ulnar articulation, which is also very rare, is caused by twists.

Symptoms and Treatment.—In *forward* dislocation at the inferior radio-ulnar articulation the forearm is pronated, the space between the styloid processes is diminished, and the ulna forms a projection posteriorly. In *backward* dislocation the forearm is supinated, the space between the styloid processes is diminished, and the ulna projects in front. Reduction is accomplished by extension and manipulation. Two straight splints (as in fracture of both bones) are to be applied for four weeks, and passive motion is to be made in the third week.

Dislocation of Individual Carpal Bones.—Pick says there is one weak spot, which is "between the head of the os magnum and the scaphoid and semilunar bones," and the os magnum may be forced up. The os magnum is the only bone dislocated with any frequency, and the injury is caused by forced flexion of the wrist.

Symptoms and Treatment.—The symptom of dislocation of the carpal bones is a firm projection which becomes more prominent during flexion of the wrist. The *treatment* is extension and manipulation, a Bond splint being worn for three weeks.

Dislocations of metacarpal bones are rare. The first metacarpal bone is most liable to dislocation.

Symptoms and Treatment.—Dislocations of the metacarpal bones are obvious because of projection. The dislocations are reduced by extension and manipulation, a straight splint and large pad for the palm are applied (as in fracture of the metacarpus), and the splint is to be worn for three weeks.

Dislocations at the metacarpophalangeal articulations are rare, and backward dislocation is the most common. The *cause* is a fall upon the hand.

Symptoms and Treatment.—Dislocated metacarpophalangeal articulations are obvious. Reduction is easily effected by extension and manipulation, except in the case of the thumb. A splint must be worn for three weeks.

Dislocation of the Metacarpophalangeal Joint of the Thumb.—In this dislocation the phalanx usually passes backward.

Symptoms.—Symptoms of *backward* dislocation are—the

base of the first phalanx rests upon the metacarpal bone; the head of the metacarpal bone projects forward and button-holes the muscles of the thumb; the first phalanx of the thumb is strongly extended, and the terminal phalanx is semiflexed. The symptoms of *forward* dislocation are—the base of the first phalanx is felt in the palm, and the head of the metacarpal bone is felt posteriorly.

Treatment.—In treating backward dislocation of the meta-carpophalangeal joint of the thumb, reduction is difficult because of the head of the bone being caught in the perforation of the flexor muscle. Always give ether. Keetley's directions are to adduct the metacarpal bone into the palm (to relax the muscles) and to have an assistant hold it; bend the thumb strongly back, extend, pull the thumb toward the fingers, and suddenly flex. To get a firm enough grasp for these manipulations use the apparatus of Charrière or of Levis (Figs. 183, 184). If the above maneuvers fail, perform tenotomy or incise freely and

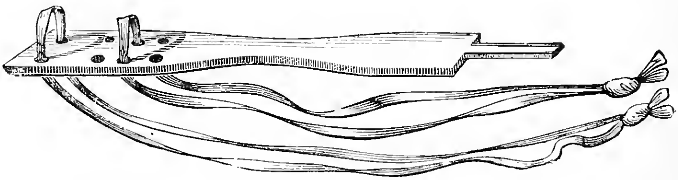


Fig. 183.—Levis's splint for reducing dislocation of phalanges.

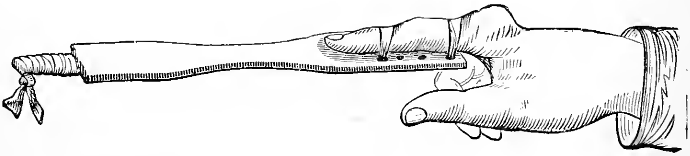


Fig. 184.—Levis's splint applied.

reduce. After reduction of this dislocation a splint must be worn for three weeks. In forward dislocation reduction is easily effected by strong extension and forced flexion. A splint is to be worn for three weeks.

Dislocations of the phalanges may be complete or may be partial. They are commonest between the first and second phalanges.

Symptoms and Treatment.—Dislocations of the phalanges are obvious. In treating such dislocations employ extension and manipulation, and use a splint for one week.

Dislocations of the Ribs and Costal Cartilages.—The ribs may be dislocated from the vertebræ. This accident is rarely uncomplicated, and cannot be differentiated from fracture. The diagnosis is rarely made, and the injury is treated as a fracture. The ribs may be dislocated from their cartilages, one or more ribs being displaced. The end of the rib forms an anterior projection, there is a depression over the cartilage, and crepitus is absent. *Treatment* is the same as that employed for fractured ribs. The costal cartilages may be displaced from the sternum, forming an anterior projection upon this bone. Reduction is brought about by placing the patient upon a table, with a sand pillow between the scapulæ, pushing back the shoulders and chest, and forcing the cartilage into place. The dressings are the same as those used in fractured sternum. The cartilages of the lower ribs (sixth, seventh, eighth, ninth, and tenth) may be separated. The inferior cartilage goes forward and can be felt. Pick states that reduction is brought about by causing the patient to hold the chest full of air while efforts are made to push the cartilage into place. Dress as for fractured ribs.

Dislocations of the Sternum.—In dislocations of the sternum the manubrium may be separated from the gladiolus in young subjects. The *symptoms* and *treatment* are the same as those in fracture (page 439).

Pelvic dislocations are almost always complicated with fracture. A pubic bone can be dislocated by falls from a height or by applying violent force to the acetabula. The dislocation may be up or down, front or back, and it may damage the urethra or the bladder. The patient cannot stand; there are great pain and recognizable deformity. Treat by moulding the bones into place, by applying a pelvic belt, and by rest in bed for four weeks. Dislocations of the sacro-iliac joint are produced by falls. Movement on the part of the patient is difficult or impossible; there is violent pain, and often paralysis (from pressure upon nerves). In dislocation backward there is an apparent shortening of the leg, eversion of the foot exists, and the ilium moves posteriorly and upward. In dislocation forward the anterior superior iliac spine projects and the pelvis is broadened. Sacro-iliac dislocations are reduced by holding the pelvis firm and making extension with a pulley. The patient stays in bed for four weeks and wears a pelvic belt as in fracture.

Dislocations of the Femur (Hip-joint).—These injuries are rare, as the hip-joint is very strong. They occur in young adults. In forcible extension the head of the femur

presses against the capsule, but the capsule here is very thick, and certain muscles, the rectus, psoas, and iliacus, are pulled tight and serve to strengthen the capsule. The head of the bone cannot go directly upward, because of the acetabulum (Edmund Owen). The weak point of the acetabular rim is below; the weak part of the capsule is also below; hence forced abduction is apt to take the head of the bone through the lower part of the capsule, a dislocation occurring primarily into the thyroid foramen. The signs of the dislocation depend upon the untorn portion of the capsule. The Y-ligament and more than the Y-ligament usually escapes laceration. Vessels are rarely injured. Muscles are often torn. In some cases the sciatic nerve is lacerated, bruised, or caught up on the neck of the bone. Four forms of hip-joint dislocation exist: (1) upward and backward, on the dorsum of the ilium; (2) backward, into the sciatic notch; (3) downward, into the obturator foramen; and (4) inward, on the pubes.

All dislocations are primarily inward or outward. From these initial positions the head may be shifted to any region about the socket within reach of the remnant of untorn capsule (Oscar H. Allis). Allis would reject the old classification. He would suggest the following:

Low thyroid, Mid- " High "	All present abduction and outward rotation.

Reversed thyroid:

Low dorsal, Mid- " High "	All present adduction and inward rotation.

Dislocation upon the dorsum of the ilium comprises one-half of all hip-dislocations. It is *caused* by a fall or a blow when the limb is flexed and abducted (as in carrying a weight upon the shoulder), by a fall upon the knees or feet, by a weight striking the back while bending, etc. Allis says rotation inward is the chief element in its production. In this dislocation the head of the femur goes upward and backward, rests upon the ilium, and is always above the tendon of the obturator internus muscle. This dislocation is secondary to a thyroid dislocation, because of muscular action shifting the bone from its initial seat of displacement.

Signs.—Dislocation on to the dorsum of the ilium is indicated by the following symptoms: the buttock looks flat and broad; the great trochanter is above Nélaton's line and is

deeply placed; the head of the bone can be detected in its new situation; deep pressure in front of the joints finds a hollow; the leg is shortened by about two or three inches, as a rule; the fascia lata is relaxed; in some thin people the socket can be outlined; when the patient is recumbent the injured extremity can be brought to the perpendicular without flexing the leg (Allis); the knee is slightly flexed; the thigh is slightly flexed, inwardly rotated, and adducted (Fig. 185), this is shown by the fact that the axis of the thigh of the injured side, if prolonged, would pass through the lower third of the sound thigh); when the capsule is extensively lacerated there may be no adduction and may *be* eversion (Allis); the heel is raised, and the great toe of the foot of the injured side rests upon the front of the instep or the ankle of the sound side; rigidity exists; voluntary movement is impossible, though some passive motion is possible in the direction of the deformity (the deformity can be made more marked). If a patient is recumbent and the knees vertical, the foot of the sound extremity is free of the bed, but the foot of the injured extremity touches the bed (Allis's sign).

FIG. 185.—Hip-joint dislocation: upward, or on the dorsum of the ilium (Cooper).

Diagnosis.—Examine first without anesthesia, and then again while the patient is anesthetized. The X-rays are valuable in diagnosis. Dislocation is separated from intracapsular fracture by noting the inversion, the great shortening, the absence of crepitus, the age of the subject, and the nature of the force. The nature of the force, the inversion, and the absence of crepitus mark the diagnosis from extracapsular fracture.

Treatment.—The chief obstacle to reduction in dislocation on to the dorsum of the ilium, Bigelow states, is the untorn portion of the capsule, especially the Y-ligament. The iliofemoral, Y, or Bigelow's ligament resembles an inverted Y, arises from the anterior inferior spine of the ilium, is inserted into the anterior intertrochanteric line, and is incorporated into the front of the capsule. To reduce a dislocation this ligament must be relaxed by manipulation or be torn by extension. Manipulation makes the head of the bone retrace its steps over the same route it took in emerging. Give ether; place the patient supine upon a mattress on the floor; flex the leg on the thigh (to relax the hamstrings), the thigh on the pelvis; increase the adduction over the middle line;

strongly abduct; perform external rotation and extension. This treatment may be summed up as flexion, adduction, external circumduction, and extension; or, as Pick puts it, "bend up, roll out, turn out, and extend." Allis's advice is to fix the pelvis to the floor, lift the head of the bone to the level of the socket, rotate outward by carrying the leg toward the pubis, and extend the femur. If extension and counter-extension are employed, make extension in the axis of the dislocated limb and obtain counter-extension by a perineal band. The extension band is fastened to the thigh by a clove-hitch. After reduction put the patient to bed and use sand-bags (as in fracture of the hip) for four weeks. We may tie the knees together instead of using the sand-bags. Passive motion is made in the third week. The pulleys must not be used in reduction. They may inflict great or even fatal injury. If the surgeon fails to reduce the deformity, there are two courses open to him. He may leave it alone. He may operate. If he leaves it alone, the limb will become ankylosed, though probably useful. Allis thinks the dorsal region will be the best place to leave it. If he determines to operate, he must recognize that tenotomy is useless. It is necessary to make a free incision in order to restore the bone.

Dislocation into the Sciatic Notch.—In this dislocation the head of the bone passes backward and a little upward, and rests upon the ischium at the margin of the sciatic notch (not in the notch), below the tendon of the obturator internus muscle. The *causes* are the same as those given for the previous dislocation.

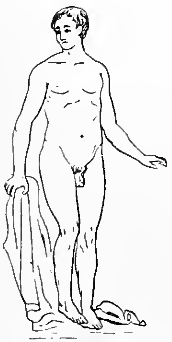


FIG. 186.—Hip-joint dislocation: backward, or into the sciatic notch (Cooper).

Signs.—The signs in dislocation into the sciatic notch are like those of dislocation upon the dorsum of the ilium, but they are not so marked. There are flattening and broadening of the hip; ascent of the trochanter above Nélaton's line; shortening to the extent of an inch; relaxation of the fascia lata. Allis's sign is present, that is, if the knee of the injured side is vertical, the sole of the foot touches the bed. Flexion, inward rotation, and adduction exist, but the axis of the femur of the injured side passes through the knee of the sound side, and the ball of the great toe of the injured side rests upon the great toe of the sound side (Fig. 186). Other symptoms

are identical with those of dislocation upon the dorsum of the ilium, but are less pronounced. Allis's signs of this dislocation are of value: if, with the patient recumbent, the thighs are brought to a right angle with the body, shortening on the affected side is materially increased; if the dislocated thigh is extended, the back arches as in hip disease.

Diagnosis and Treatment.—The signs of dislocation into the sciatic notch are similar to, but are less marked than, those of dorsal dislocation, and, being a backward dislocation, the reduction and treatment are the same as for dislocation backward upon the dorsum of the ilium.

Dislocation Downward into the Obturator Foramen.—Downward dislocation is the primary position of most dislocations of the hip, the bone rarely remaining in the thyroid foramen, but usually mounting up as a result of muscular action or of the initial violence. The *cause* is violent abduction by falls or by stepping from a moving car.

Signs.—Dislocation downward into the obturator foramen is indicated by flattening of the hip; the head of the bone is felt in its new position and is missed from the acetabulum; rigidity exists; passive motion is only possible in the direction of deformity, and that to a slight extent; a hollow is noted over the great trochanter, which process is well below Nélaton's line and nearer than normal to the middle line. There is a depression from relaxed muscles and fascia noted between the ilium and femur. The gluteal crease is lower than is the crease of the opposite side; there is lengthening to the extent of one to two inches; the body is bent forward by the traction upon the psoas and iliacus muscles, and is also deviated to the side, thus causing great apparent lengthening; the limb is advanced partially flexed and abducted, and the foot is pointed straight ahead or is a little everted (Fig. 187); when the patient is recumbent extension is impossible, the knees cannot be pushed together without great pain, and the abductor muscles are hard and rigid. Allis's sign is absent. Unreduced dislocations do well, the patient obtaining a very useful hip-joint (Sédillot).

Treatment.—In treating dislocation downward into the obturator foramen give ether and effect reduction if possible by manipulation, and, if this fails, by extension. To reduce by manipulation, flex the leg on the thigh and the thigh on the pelvis, and then perform, in the following order, abduction, internal circumduction, and extension. Allis's rule of reduction is as follows: flex the pelvis to the floor; pull the head outward and above the socket; fix the head;

push knee toward sound knee; extend femur. If extension is made, make traction in the axis of the limb by means of muslin fastened around the thigh by a clove-hitch. Do not use the pulleys; operate rather than use them.

Dislocation upon the pubis is very rare. The head of the bone usually rests just internal to the anterior inferior

FIG. 187.—Hip-joint dislocation: downward into the obtutator or thyroid foramen (Cooper).

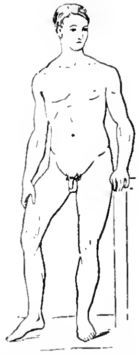


FIG. 188.—Dislocation on the pubis (Cooper).

spine of the ilium. The primary position of the bone is in the thyroid foramen; the pubic dislocation, when it occurs, is always secondary, and is due to the initial force and to muscular action.

Symptoms.—In pubic dislocation the head of the bone can be felt and seen in its new position; the hip is flattened; there is a hollow over the great trochanter, this process being found below the anterior superior spine of the ilium; there is shortening to the extent of an inch; the limb is in abduction with eversion (Fig. 188), and the knees cannot be approximated without great pain. When the knee is perpendicular the foot of the injured side touches the foot of the bed.

Treatment.—In the treatment of pubic dislocation give ether and employ manipulation as for thyroid dislocation. If this fails, employ extension. The limb is well abducted, extension is made downward and backward, and the head of the femur is pulled outward "by a towel around the thigh, just beneath the groin" (Keetley). The after-treatment is the same as that for the previous forms.

Anomalous Dislocations of the Hip.—In *supraspinous dislocation* the dislocation of the hip is backward, the head

of the femur resting upon the ilium above or even anterior to the anterior superior spine. In *ischial dislocation* the dislocation is downward and backward, the head of the femur resting on the ischial tuberosity or in the lesser sciatic notch. *Monteggia's dislocation* is a supraspinous dislocation with eversion of the limb. In *perineal dislocation* the head of the femur is in the perineum. In *suprapubic dislocation* the head of the femur passes above the pubes. In *subspinous dislocation* the femoral head rests on the horizontal ramus of the pubes.

Dislocation with Catching Up of Sciatic Nerve upon Reduction.—This accident causes severe pain. The leg is flexed on the thigh and the thigh is flexed on the pelvis. Allis tells us that the task of reduction is very unpromising. We must strive to put the neck of the femur in such a position that the nerve will "drop off," and yet often the nerve cannot drop off because it is held by adhesion to the injured muscles. Allis attempts reduction by the following plan:

1. Place the patient upon his back and redislocate the femur.
2. Extend the thigh.
3. Flex the leg on the thigh.
4. Turn ankle out until the leg is horizontal (this causes the head to look downward).
5. "Shake, shock, jar, adduct and abduct," to disengage the nerve.
6. Rotate into socket without flexing the leg (without making the nerve tense).
7. If this fails, make an incision above the popliteal space, and draw the nerve out of the wound. Detach the head from its entanglement and rotate it into the socket.

Dislocation of Head of Femur with Fracture of Shaft.—We may incise and replace and wire the fragments. We may use McBurney's hooks as in the shoulder. We may be forced to do a resection of the head.

Allis maintains that it is possible to reduce it by manipulation. He states that the upper fragment is the entire lever, and the lower fragment "is only the agent through which we apply our force." The fragments are not completely separated, but are connected at one side by material which is "partly periosteal, partly tendinous, and partly muscular." This connecting material enables us to make traction upon the upper fragment, but does not allow "rotation, circumduction, and leverage through the agency of the lower frag-

ment." Hence "the only agency at our command is traction." If the dislocation is inward (forward), draw the head outward and have an assistant make direct pressure upon the head. If this fails, the assistant holds the head to prevent its slipping into the thyroid depression, and the surgeon makes traction inward or inward and downward. If the dislocation is outward (backward), make traction directly upward to lift the head to the level of the socket, and try to place the head over the socket by traction obliquely upward and inward. During all these manipulations an assistant presses upon the trochanter to prevent the head slipping back. Traction is now made downward and inward, and the tightened ligament drags the head into place.

Dislocations of the Knee.—These dislocations are rare. There are four forms—forward, backward, inward, and outward. They may be complete or be incomplete; the commonest dislocations are lateral. The *cause* is violent force, such as a fall, or in jumping from a moving train, or in being caught by the foot and dragged.

Dislocation Forward of the Knee-joint.—In the *complete* form of forward dislocation the deformity is obvious. The limb is usually extended, but it may be flexed. Much shortening exists; the condyles are felt posterior and below; the head of the tibia is felt anterior and above; the patella is movable and the quadriceps is lax; pressure of the condyles upon the contents of the popliteal space arrests the tibial pulse and causes edema and intense pain. In *incomplete* dislocation the symptoms are identical in kind, but are less pronounced.

Treatment.—Compound dislocation of the knee-joint often demands excision or amputation. In simple dislocation give ether, have one assistant extend the leg while another makes counter-extension on the thigh, and the surgeon pushes the bone into place. Reduction is easy because of ligamentous laceration. Place the limb on a double inclined plane, and combat inflammation by the usual methods (see Synovitis, page 510). Begin passive motion in the third week. The patient must wear a knee-support for months. If the popliteal vessels are much damaged, gangrene will supervene and amputation will be demanded.

Dislocation Backward of the Knee-joint.—In the *complete* form of knee-joint dislocation backward displacement is not so great as in dislocation forward. The head of the tibia projects posteriorly and above, the femoral condyles anteriorly and below; the leg is, as a rule, partly flexed,

but it may be extended, and there is moderate shortening. In *incomplete* dislocation the symptoms are less marked.

Treatment.—The treatment of backward dislocation of the knee-joint is the same as for forward dislocation.

Dislocation Outward of the Knee-joint.—Is usually incomplete. The inner tuberosity of the tibia in outward dislocation lies upon the outer condyle of the femur (Pick); the inner condyle of the femur projects internally; the outer tibial tuberosity and fibular head project externally, the former having a depression below it, and the latter above it; the leg is semiflexed, but shortening is absent.

Dislocation Inward of the Knee-joint.—Is usually incomplete. The outer tuberosity of the tibia in inward dislocation lies upon the inner condyle of the femur; the outer condyle of the femur forms an external prominence, and the inner tuberosity of the tibia forms an internal prominence. Pick cautions us not to mistake a separation of the lower femoral epiphysis for lateral dislocation (the former is reduced easily, the deformity tends to recur, and there is soft crepitus).

Treatment.—In treating lateral dislocation of the knee-joint, effect extension and counter-extension as in antero-posterior dislocations. The leg is moved from side to side and attempts are made at rotation. The after-treatment is the same as that for anteroposterior luxations.

Dislocations of the Patella.—Are usually acquired. There are thirty-five congenital cases on record (Bajardi). There are three forms: outward, inward, and edgewise. The so-called dislocation upward is in reality rupture of the ligamentum patellæ (page 618).

Dislocation outward may be due to muscular action or to direct force, and occurs during extension of the leg. It occasionally happens in a person with knock-knees. If the dislocation is complete, the bone lies upon the external surface of the external condyle; if incomplete, the patella rests upon the anterior surface of the external condyle. The leg is extended, flexion is impossible, and attempts at flexion produce great agony. The knee is wider than normal. There is a hollow in front of the joint. The bone is felt in its new position.

Dislocation inward is extremely rare. The signs of this dislocation are like the signs of dislocation outward, except that the patella rests upon the inner condyle.

Treatment.—Give ether. Raise the body upon a bed-rest, and flex the thigh. Grasp the patella, depress the margin of the patella which is farthest from the center of the joint

(Pick). The muscles pull the bone into place. Immobilize for three weeks, when passive motion is begun. Incision may be necessary in order to effect reduction.

Dislocation of the Patella Edgewise.—The patella rotates vertically, one edge resting between the condyles. As a rule, the outer border is in the intercondyloid notch (Pick). This condition is produced by direct force when the extremity is partly flexed. Twisting and muscular action have been assigned as causes. The condition is obviously manifest.

Treatment.—Give ether. Pick recommends "sudden and forcible bending of the knee." In some cases the bone can be pushed into place, the limb being extended and flexed as in the reduction of a lateral dislocation. In some cases incision will be necessary.

Dislocation of the Semilunar Cartilages of the Knee (the Internal Derangement of Hey; Subluxation of the Knee-joint).—These interarticular cartilages are attached in front of and behind the tibial spine, and their convexity is attached to the edge of the tibial tuberosities by the coronary ligament. The inner cartilage is connected with the internal lateral ligament, and it has a moderate freedom of movement; the outer cartilage is not connected with the external lateral ligament, and is not freely movable, yet the outer is more often dislocated than is the inner cartilage. People who kneel much are predisposed to this accident (Annandale). The *cause* is a twist when the knee is flexed, as in stubbing the toe.

Symptoms.—The indications of interarticular-cartilage dislocation are a sudden, violent, sickening pain in the knee, that may cause the patient to fall; the position is one of fixed semiflexion, voluntary motion being impossible and passive motion causing fierce pain; a displacement of either cartilage away from the tibial spine produces a prominence on one or the other side of the knee-joint, and a displacement toward the tibial spine makes a prominence on one side of the ligament of the patella. Subluxation is soon followed by inflammation of the cartilages and of the joint, and swelling rapidly masks the projection. This accident is usually mistaken for blocking of the joint by a floating cartilage. One point in diagnosis is that a loose cartilage changes its position, but a dislocated cartilage remains always in the same position (Turner).

Treatment.—In treating dislocation of the semilunar cartilages of the knee give ether and reduce by forced flexion and sudden extension with rotation, at the same time endeavoring to push the projecting cartilage into place. After reduc-

tion combat inflammation, apply a splint, and use the proper remedies for one week (see Synovitis), then begin passive motion. As recurrence of the displacement is usual, the patient should wear a knee-cap for a year or more. If reduction is impossible, persistent passive motion will usually secure a useful joint. In intractable cases incise and stitch the cartilages or remove the loosened portion (Annandale).

Dislocations of the Fibula: Dislocation at the Superior Tibiofibular Articulation.—This injury is rare. The head of the fibula may go forward or backward. The *causes* are direct force and violent adduction of the foot with abduction of the knee (Bryant).

Symptoms.—In dislocation of the fibula the position is one of semiflexion, voluntary extension and flexion being impaired or lost. A distinct movable projection is readily noticed in front or behind, which is found to be continuous with the fibula. There is a depression over the normal position of the head of the fibula.

Treatment.—In treating dislocation of the fibula bend the knee to relax the biceps, and proceed to push the bone into place. Put a compress over the head of the fibula, apply a bandage, and put the limb on a double inclined plane for three weeks. At the end of this time put a lacing knee-support upon the knee and let the patient up. Displacement being liable to recur, a knee-cap must be worn for a year.

Dislocations of the Ankle-joint.—These injuries are not unusual. Fracture is a frequent complication. There are five forms of ankle-joint dislocation—outward, inward, forward, backward, and upward.

Lateral dislocations of the ankle-joint are either outward or inward, and may be complete or incomplete. In these dislocations the astragalus rotates. In incomplete dislocations "there is no great separation of the trochlear surface of the astragalus from the under surface of the tibia, but the outer or inner margin of this surface is brought into contact with the articular surface of the tibia, and the whole foot presents a lateral twist" (Pick). The *causes* of these dislocations are twists of the joint.

Symptoms.—Incomplete outward dislocation of the ankle-joint is known as *Pott's fracture* (see page 505). Complete outward dislocation, in which the articular surface of the astragalus is completely displaced outward from the articular surface of the tibia, and which condition is associated with a fracture of the fibula and separation of the inferior tibiofibu-

lar articulation, is known as *Dupuytren's fracture.* In incomplete dislocation the foot goes outward and upward, the fibula is fractured, and the tibiofibular ligaments are torn off. In Dupuytren's fracture the ankle is broad, the inner malleolus projects and looks lower than natural, the outer malleolus ascends with the foot, the foot rotates outward, and crepitus can be found. In inward dislocation which is associated with fracture of the inner malleolus there is inversion, the outer malleolus projects, and crepitus can be found. In incomplete separation the symptoms are similar, but are not so marked.

Treatment.—In treating a case of dislocation of the ankle-joint the deformity is reduced by flexing the leg on the thigh and the thigh on the pelvis; an assistant makes counter-extension from the knee; the surgeon makes extension from the foot, and at the same time rocks the astragalus into place. Dupuytren's fracture is treated in the same manner as Pott's fracture (page 505). Dislocation inward is treated in a fracture-box for the same period as Pott's fracture.

Anteroposterior dislocations of the ankle-joint are rare. The *cause* is the catching of the foot in jumping or falling—direct violence. In dislocation forward the foot is lengthened, the heel is not conspicuous, the tibia and fibula project against the tendo Achillis, and the relation of the malleoli to the tarsus is altered. In incomplete dislocation the symptoms are similar, but less pronounced. In dislocation backward the foot is shortened, the tibia and fibula project in front, the heel is prominent, and the relation between the malleoli and the tarsus is altered. In incomplete dislocation the symptoms are similar, but less marked.

Treatment.—In anteroposterior dislocation of the ankle-joint, reduce as in lateral dislocations. Sometimes the tendo Achillis must be cut. Apply a silicate-of-sodium dressing, and let it be worn for two weeks; then begin passive motion, and let the patient wear side-splints for a week longer.

Dislocation upward of the ankle-joint, or Nélaton's dislocation, is a very rare injury. The astragalus is wedged between the widely separated tibia and fibula. This dislocation is usually associated with fracture. The *cause* is a fall upon the feet from a great height.

Symptoms.—Upward dislocation of the ankle-joint is indicated by the widening of the ankle and by the flattening of the foot. The malleoli are nearly on a level with the plantar surface of the foot, and there is absolute rigidity.

Treatment.—In treating upward dislocation of the ankle-

joint give ether, and try to reduce by powerful extension and counter-extension. Treat the injury afterward in the same manner as for an anteroposterior luxation.

Dislocation of the Astragalus.—The astragalus may be displaced from the bones of the leg and at the same time be separated from the rest of the tarsus. The displacement may be forward, backward, outward, inward, or rotary.

Dislocation of the astragalus forward or backward is caused by falls or twists.

Symptoms.—In forward dislocation the astragalus projects strongly; there is shortening of the foot, and the malleoli approach the plantar aspect of the foot; the foot is deviated to one side or to the other, and there is absolute rigidity of the ankle-joint. In incomplete luxations the symptoms are similar, but less marked. This dislocation may be obliquely forward. In backward dislocation of the astragalus the foot is not deviated to either side; the astragalus projects between the malleoli and above the os calcis, and the tendo Achillis is stretched over the projection. Rigidity is absolute. This dislocation may be obliquely backward.

Lateral and Rotary Dislocations of the Astragalus.—Lateral dislocations of the astragalus are rare, are always compound, and are always associated with fracture. In rotary dislocation the astragalus remains in its normal habitat after rotating on its own axis, either horizontal or vertical. The *causes* of rotary dislocation are twists of the foot when it is at a right angle to the leg (Barwell). The *symptoms* of rotary dislocations are obscure. There is rigidity, but sometimes portions of the astragalus may be made out.

Treatment of Dislocations of the Astragalus.—In treating astragalus dislocation reduce under ether by flexing the knee to relax the gastrocnemius, extending the foot, and pushing the bone into place. It may be necessary to cut the tendo Achillis. After reduction put up the foot and leg in silicate-of-sodium dressing for two weeks, and then begin passive motion and apply side-splints, which are to be worn for one week more. If reduction fails, support the limb on splints, combat inflammation, and endeavor to bring about union between the dislocated bone and the tissues. Often, in unreduced dislocation, the skin sloughs over the projecting bone. Excision is demanded the moment sloughing is seen to be inevitable. Cases of compound dislocation of the astragalus require immediate excision.

Subastragaloid Dislocation.—This condition is a separation of the astragalus from the os calcis and scaphoid,

without separation of the astragalus from the bones of the leg. Pick states that the usual classification for these dislocations is forward, backward, inward, and outward, but that the displacement is, as a rule, oblique, the foot passing backward and outward or backward and inward. The *causes* are twists.

Symptoms.—In subastragaloid dislocation the astragalus projects on the dorsum; the foot is everted in outward dislocation and inverted in inward dislocation; the relation of the malleoli to the astragalus is unaltered; the ankle-joint is not absolutely rigid; the foot "is shortened in front and is elongated behind" (Pick).

Treatment.—To treat subastragaloid dislocation make extension in the direction opposite to that of the displacement. In dislocation of the tarsus backward fix a bandage around the foot, on a level with the heads of the metatarsal bones, which bandage the surgeon ties around his shoulders. The surgeon puts one knee in front of the angle and thus fixes the leg, raises himself up to make extension upon the tarsus, and moulds the bone into position. Tenotomy may be necessary. After reduction apply a silicate dressing for three weeks. The ankle-joint, fortunately, is not involved, and stiffness of this articulation need not be apprehended. If reduction is impossible, take the same course as in luxations of the astragalus.

Dislocations of the other tarsal bones are very rare. Single bones may be dislocated, or the luxation may occur at the mediotarsal articulation.

Symptoms and Treatment.—Projection is an obvious symptom in dislocation of the other tarsal bones. The *treatment* is to reduce by extension and moulding, the part being put up in silicate-of-sodium dressing for two weeks.

Dislocations of the metatarsal bones are rare.

Symptoms and Treatment.—Shortening of the toes and projection of the dislocated bone are symptoms of dislocation of the metatarsal bones. To *treat* these dislocations reduce by extension under ether and put up in a silicate dressing for two weeks. If reduction fails, the functions of the foot will not be much impaired.

Dislocations of the phalanges are very rare. The first phalanx of the big toe is the one most liable to dislocation.

Symptoms and Treatment.—Dislocations of the phalanges are obvious. The *treatment* is by reduction as in dislocations of the thumb. Immobilize for two weeks.

5. Operations upon Bones.

Osteotomy.—By the term *osteotomy* the modern surgeon means literally the sectioning of a bone for the purpose of straightening a limb ankylosed in a bad position, correcting a bony deformity, or amending a vicious union of a fracture. In a *linear osteotomy* the bone is transversely divided in one spot; in a *cuneiform osteotomy* a wedge-shaped portion of bone is removed. The operation of osteotomy may be performed with a saw (Fig. 189) or with an osteotome. The saw creates dust, draws much air into the wound, and lacerates the tissues to a considerable degree. Most surgeons prefer the chisel or the osteotome. The osteotome slopes down to a point from each side (Fig. 190); the chisel is straight on one side and on the other is bevelled to a point.

Osteotomy for Genu Valgum, or Knock-knee (Macewen's Operation, Fig. 192).—In this operation the instruments re-

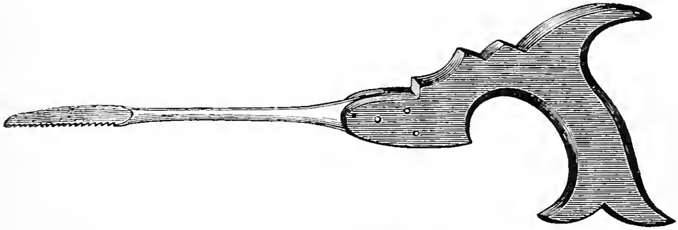


Fig. 189.—Adams's large saw.

Fig. 190.—Osteotome.

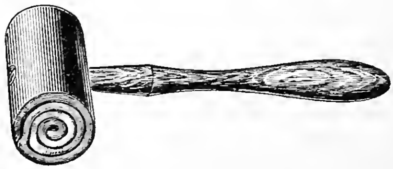


Fig. 191.—Rawhide mallet.

quired are the scalpel, hemostatic forceps, osteotomes of several sizes, a mallet (Fig. 191), and a sand-bag wrapped in an aseptic towel.

Operation.—The patient lies upon his back, being rolled a little toward the diseased side. The leg of the diseased side is partly flexed upon the thigh and the thigh upon the pelvis, and the extremity is laid upon its outer surface, the sand-bag being pushed between the extremity and the bed, opposite to the site of section. The flexion of the knee relaxes the popliteal vessels and saves them from injury. The surgeon, if operating on the right leg, stands outside of that ex-

tremity; if operating on the left leg, he stands opposite the left hip (Barker). Enter the knife at the inner side of the knee, just in front of the adductor tubercle of the inner condyle and on a level with the upper border of "the patellar articular surface of the femur" (Barker); cut down to the bone, and make an incision upward one inch in length, in the direction of the axis of the femur. At the lower angle of this wound insert an osteotome and turn it to a right

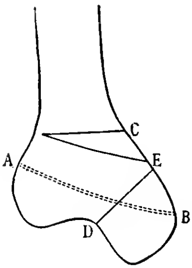


Fig. 192.—Osteotomy of the right femur in a case of knock-knee: A B, epiphyseal line; C, section of Macewen: D E, section of Ogston.

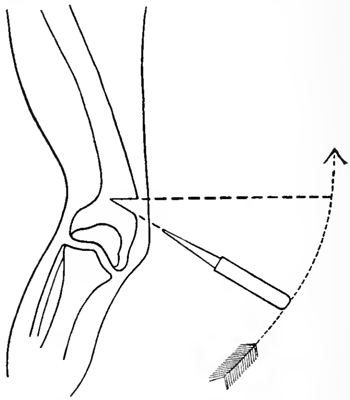


Fig. 193.—Macewen's operation for genu valgum: the chisel is held in the line for striking with a mallet; the arrow shows the direction in which the chisel is levered up and down so as to make a wide gap in the bone (after Barker).

angle with the shaft, half an inch above the epiphysis (Fig. 192); strike the osteotome several times with a mallet; move the handle several times toward and from the body, so as to widen the cut in the bone (Fig. 193); strike the osteotome again several times, move it again, and continue this process until the bone is cut one-third through. If the osteotome becomes tightly fixed, withdraw it and introduce a smaller one. When the bone is cut two-thirds through withdraw the osteotome, hold a piece of wet antiseptic gauze over the opening, and fracture the femur by strong adduction. Do not suture nor drain the wound, but dress it antiseptically, wrap the entire extremity in cotton, and apply a plaster-of-Paris dressing up to the groin. This dressing may be removed in two weeks, and the patient may subsequently be treated with sand-bags, as for an ordinary fracture of the thigh, but without extension. This operation is scarcely ever fatal.

Ogston's Operation (Fig. 192).—In this operation the internal condyle is sawed off obliquely with an Adams saw—a proceeding which permits the straigthening of the knee. The objection to this operation is that it opens the knee-

joint, and that this cavity fills up more or less with a mixture of blood and bone-dust. Macewen's operation is decidedly the safer.

Osteotomy for a Bent Tibia.—In this operation the instruments required are the same as those indicated in the above operation. The tibia is divided transversely or obliquely (linear osteotomy), or a wedge-shaped piece is removed (cuneiform osteotomy). The oblique incision is the best. If the convexity of the tibial curve is inward, cut the bone from above downward and from in front backward; if the curve is forward, section the bone from above downward and from within outward. The fibula need rarely be interfered with. After the osteotomy the limb is treated just as it would be for an ordinary fracture.

Osteotomy for Faulty Ankylosis of the Hip-joint.—This operation is performed in order to allow straightening of a limb that has undergone bony ankylosis in a faulty or an inconvenient position. In some cases an attempt is made to obtain a movable joint, but in most cases the surgeon must be satisfied with an ankylosis in extension. Osteotomy may be performed through the neck of the femur or through the shaft of the femur below the trochanters.

Osteotomy through the neck of the femur is performed (1) with a saw (Adams's operation) or (2) with an osteotome.

1. *Adams's Operation* (Fig. 194).—In this operation the instruments required are a scalpel, hemostatic forceps, a long, blunt-pointed tenotome, and an Adams saw.

Operation.—The patient lies upon his sound hip; the surgeon stands upon the side to be operated upon, and back of the patient. The knife is entered a finger's breadth above the great trochanter, is pushed in until it strikes the neck of the bone, is then carried across the front of and at a right angle with the neck, and is withdrawn, enlarging the wound in the soft parts, as it emerges, to the extent of an inch. The saw is now introduced and the neck is entirely divided. After the osteotomy dress the wound antiseptically and place the extremity straight. To straighten the limb it may be found necessary to cut contracted tendons and fascial bands. Apply the weight-extension apparatus and the sand-bags. Begin passive movements from the start if a movable joint is desired; few patients can

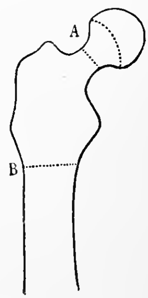


FIG. 194.—Osteotomy through the neck of the femur: A, Adams's operation; B, Gant's operation.

tolerate the pain necessary to bring this about. If it is determined to aim for a stiff joint, treat the case as an intra-capsular fracture would be treated.

2. *With an Osteotome.*—The instruments required in this operation are the same as those used for genu valgum. No sand-bag is required. The position of the patient is the same as that in Adams's operation. An incision one inch long is made, starting just above the great trochanter, ascending in the axis of the femoral neck, and reaching to the bone. An osteotome is introduced, is turned to a right angle with the bone, and is struck with a mallet until the bone is *completely* divided. (It is not to be divided partially and then broken.) The after-treatment is the same as that for Adams's operation. The operation with the osteotome is to be preferred to that by the saw.

Osteotomy of the Shaft of the Femur below the Trochanters (Gant's Operation).—In this operation (Fig. 194) the saw may be used, but the osteotome is to be preferred. The instruments employed are the same as those used for Adams's operation, plus an osteotome.

Operation.—The position in Gant's is like that in Adams's operation. A longitudinal incision one inch long is made upon the outer aspect of the femur and on a level with the lesser trochanter. The osteotome is inserted and the bone is completely divided below the lesser trochanter. The after-treatment is the same as that for Adams's operation. Gant's operation is the best method for correcting faulty position in bony ankylosis, and Adams's operation can only be employed in those cases where the femur still has a neck which practically is unchanged.

Osteotomy for Faulty Ankylosis of the Knee-joint.—This operation is performed for bony ankylosis of a knee in a position of flexion. The instruments employed are the same as those used for genu valgum.

Operation.—The patient lies upon his back with his thighs flat upon the bed, the legs hanging over the end of the bed. The surgeon stands on the patient's right side. Just above the patellar articular surface upon the femur a transverse incision is made, one inch in length and reaching to the bone. The osteotome is introduced and the bone is cut *nearly* through. The leg is then forcibly extended. Do not extend too violently, or the popliteal vessels may be injured. In cases where the structures of the popliteal space are tense, do not at once bring the leg into extension, but do so gradually by means of weights. The wound is dressed

aseptically, and the extremity is placed upon a double inclined plane and is treated as for fracture near the knee-joint.

Osteotomy for vicious union of a fracture is performed in case of angular deformity, and is carried out in the same manner as are the above procedures. It is best, when possible, to enter the osteotome upon the concavity of the bent bone, so that the periosteum will not rupture when extension is made, and the patient will in consequence gain a longer limb.

Osteotomy for Hallux Valgus.—In this operation a linear osteotomy is made through the neck of the metatarsal bone of the great toe, the toe is forcibly adducted, and a splint is applied to the inside of the foot and the toe.

Osteotomy for Talipes Equinovarus.—The instruments required in this operation are a scalpel, hemostatic forceps, a narrow, blunt-pointed saw, special directors, bone-cutting forceps, sequestrum-forceps, and scissors.

Operation (after Barker).—The patient lies upon his back, the thigh is semiflexed, the knee is bent, and the sole of the foot rests upon the table. The surgeon stands to the right side if it is the right limb to be operated upon, or to the left side if it is the left limb. Feel for the outer surface of the cuboid bone, and cut away from over the latter a piece of skin corresponding in size with the bone-wedge intended to be removed (this piece of skin must include the bursa which forms in these cases). Turn the foot outward, find the astragaloscaphoid articulation, over which make an incision "from the lower to the upper dorsal border of the scaphoid bone" (Barker), reaching through the skin only; place the foot again in the first position, raise all the soft parts from off the superior surface of the tarsus, and clear a triangular surface corresponding with the base of the wedge to be removed; pass a "kite-shaped" director (Fig. 195) into the external wound, and cause it to project from the internal wound; push the saw through the groove of the director nearest the toes, and saw through the tarsus, from the dorsum to the sole, at right angles to the metatarsal bones; push the saw through the groove of the director nearest the ankle, and saw from the dorsum to the sole, at right angles to the long axis of the calcaneum; grasp the wedge-shaped piece of bone with sequestrum-forceps, and cut it out with scissors, with bone-forceps, or with a blunt bistoury. The wound is well irrigated, the foot is straight-

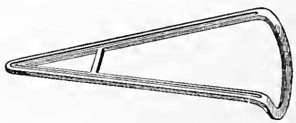


FIG. 195.—Davy's director (Pye).

ened, the internal wound is sewed up, the external wound is sutured except at its lowest portion, where a drainage-tube is to be retained for twenty-four hours, and the wound is dressed antiseptically. The foot is put up in plaster or is put upon a Davy splint.

Osteotomy for Talipes Equinus.—This operation is described by Mr. Davy, who devised it, as follows:[1] "Taking the line of the transverse tarsal joint as a guide, on the outer and inner sides of the foot, and immediately over the joint, two wedge-shaped pieces of skin are removed, equal in extent to the amount of bone demanded. The soft structures are freed on the dorsum of the foot in the way previously described; but, as the base of the osseous wedge for equinus cases is at the dorsum and its apex at the sole, the parallel wire director, instead of the kite-shaped varus one, is used. The saw is successively inserted in its grooves, and by keeping in mind the idea of a keystone a clean wedge of bone is cut out from the dorsum to the sole of the foot." The wedge is extracted, and the foot is straightened and is put in plaster or in a Davy splint.

Operative Treatment of Recent Fractures.—In recent fractures where reduction is impossible or where displacement recurs in spite of splints, it may be advisable to operate. In such cases a skiagraph should always be taken, and it will often decide whether operation is or is not indicated. In most instances of irreducible fracture reduction of the fragments is impossible because of muscle or fascia caught between them or because of hardening and shortening of periosteal soft parts, due to hemorrhage and inflam-

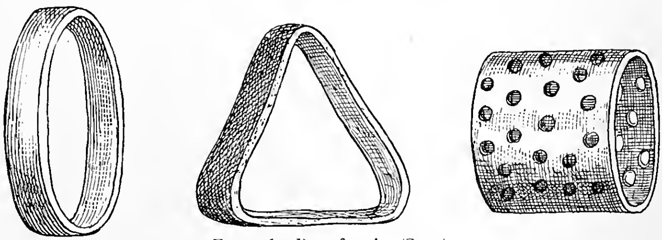


FIG. 196.—Bone ferrules (Senn).

mation. In such cases it may be necessary to make a tolerably long incision; the ends of the fragments are loosened from their anchorage, the inflammatory ties are cut, tissue is removed from between the fragments, and if the ends are very irregular they are sawn off evenly.

[1] Barker's *Manual of Surgical Operations.*

The fragments are bored and brought together, and are held by silver wire or kangaroo-tendon, or both fragments are surrounded by Senn's bone ferrule, and fixation is thus secured (Figs. 196, 197). Drainage is unnecessary, the soft parts are

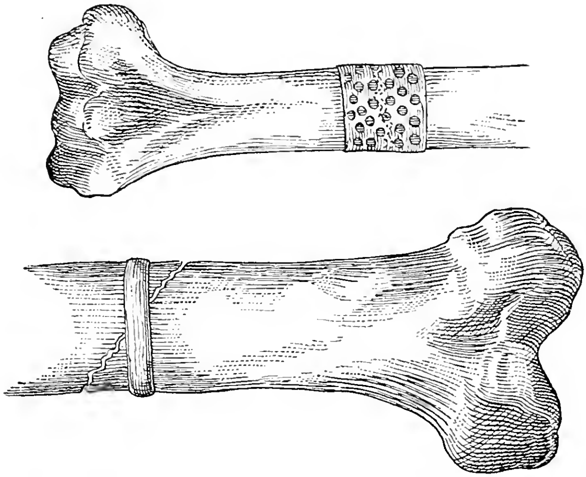


FIG. 197.—Bone ring and ferrule applied (Senn).

sutured and dressed with sterile gauze, and the extremity is put up in plaster. If the clavicle is operated upon, after sterile dressings are applied a Velpeau bandage is put on, and the turns of this bandage are overlaid with plaster-of-Paris, a trap-door being cut over the seat of operation. In such operations the author does not use an Esmarch bandage, as he believes it best to see what is cut and thoroughly arrest bleeding at the time, rather than run the danger of oozing and infection.

The author has wired recent fractures of the humerus, tibia, femur, and clavicle. Arbuthnot Lane believes that every very oblique fracture of the tibia and fibula low down should be treated by incision and fixation.[1] It is necessary to bear in mind that if one of two parallel lines is broken (as the radius alone or tibia alone), and it is found necessary to resect a considerable portion, a like amount should be resected from the companion bone in order to prevent great deformity.

Recent Transverse Fracture of the Patella (see page 495).

[1] *Brit. Med. Jour.*, April 20, 1895.

Bone-grafting, or Transplantation (see page 398).

Operative Treatment of Ununited Fracture.—The instruments required in this operation are a scalpel, hemostatic forceps, dissecting-forceps, retractors, Allis's dissector,

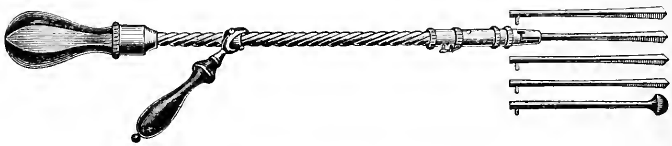


FIG. 198.—Hamilton's improved bone-drills.

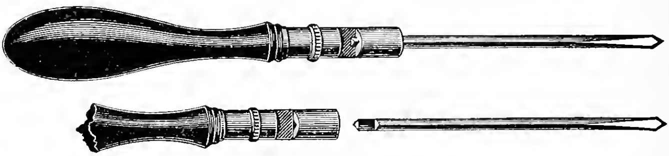


FIG. 199.—Brainard's drills with Wyeth's adjustable handles.

an awl or special drill (Figs. 198, 199), chisels, a mallet, a fine saw, lion-jaw forceps, and silver wire.

In operating, incise longitudinally down to the seat of fracture, retract the periosteum from the bone, drill the bones before cutting them, chisel away the material of imperfect union, saw through each end far enough from the seat of fracture to reach sound tissue, pass large silver wires through the holes (this wire should be one-tenth inch in diameter for the femur, one-sixteenth inch for the patella, etc.) (Fig. 200),

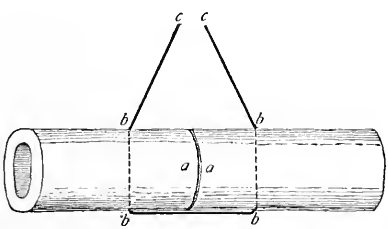


FIG. 200.—Wiring of bones for ununited fracture: *aa*, sawn surfaces approximated after removal of old material which was interposed between the fragments; *bb*, *bb*, perforations drilled completely across the bone; *cc*, wires ready for twisting.

twist the wires a fixed number of times (two complete turns) in the direction that the hands of a watch move (this is Keen's direction in case removal of the wires should be

demanded), sever the ends of the wires, and hammer their stems against the bone. The wires may never require removal. Dress the part as a recent fracture. Various plans besides wiring have been employed in ununited fracture. Gussenbauer's clamp is used by some. Clayton Parkhill's bone-clamp is a very useful appliance, and holds the fragments firmly in contact (Fig. 116). Menard and Lannelongue inject a 1 : 10 solution of chlorid of zinc between the fragments and around their ends, and then immobilize the parts. Some surgeons unite the fragments with kangaroo-tendon instead of wire (suturing of bone); others use nails of bone or ivory; others use screws. Senn asserts that the above methods will not hold fragments in contact if these fragments have a tendency to become displaced. Senn fastens the bones together by hollow cylinders of decalcified bone or ivory, the cylinders being perforated in many places (bone ferrules) (Fig. 196). The soft parts are sutured, no drain is used, and the limb is encased in plaster.

Ununited Fracture of Patella.—An incision is made in the long axis of the limb, over the middle of the space between the fragments, from well above the upper fragment to well below the lower piece; this incision divides all the soft parts. The soft parts are retracted, but the periosteum is undisturbed; each fragment is bored (Fig. 201, 1) in one or two places; the surfaces of the fragments are cut square through sound bone with a saw; all old reparative material is cut away; the wires are passed through the perforations, twisted, cut off, and hammered down as before (Fig. 201, 2). If the ends cannot be approximated, it may become necessary to incise the muscle around and above the patella or to partially separate the tuberosity of the tibia and bend this process upward. A small drain is inserted above the bone, the wound is sutured, aseptic dressings are applied, and the limb is put upon a Macewen splint.

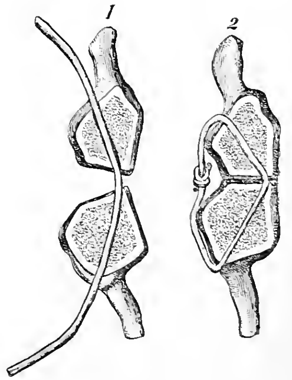


FIG. 201.—Wiring of the patella: 1, fragments cut and cleaned and the wires passed: 2, wires twisted and hammered down upon the bone (after Barker).

Treves's Operation for Caries of the Lumbar and Last Dorsal Vertebræ.—In this operation the right loin is chosen for incision, as a rule. The instruments required

38

are a scalpel, hemostatic forceps, grooved director, an Allis dissector, sequestrum-forceps, curet spoons, and a sand bag.

Operation.—The patient lies upon his left side, with the knees drawn up and a sand bag under him. The surgeon stands behind the patient (Barker). An incision is made at the outer border of the erector spinæ mass, reaching from the last rib to the iliac crest and going down at once to the lumbar fascia. The lumbar aponeurosis is opened, the erector spinæ is retracted inward, and the anterior portion of the erector spinæ sheath is incised. The quadratus lumborum muscle is next cut, and then the anterior leaflet of the lumbar aponeurosis is slit. Loose pieces of bone are removed with forceps, and cavities are thoroughly curetted. The wound is irrigated with corrosive sublimate and is dusted with iodoform; a large tube is inserted; the wound is packed with iodoform gauze, is partly closed by sutures of silkworm gut, and is dressed antiseptically.

Aspiration of Joints.—In certain cases of joint-effusion from inflammation, tubercular or otherwise, and sometimes in hemorrhage into a joint, it is desirable to remove the fluid by aspiration. The pneumatic aspirator is used (Fig. 202).

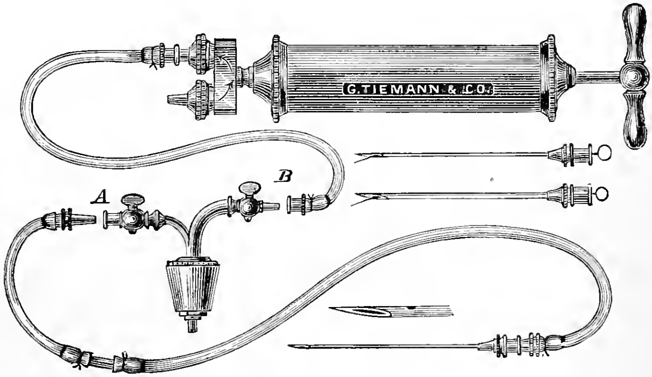


FIG. 202.—Aspirator and injector.

The trocar and cannula are thoroughly asepticized and the joint is prepared as for a set operation. The needle is entered at a surface free from vessels. The directions for using an aspirator are as follows: insert the stopper firmly into a strong bottle (a clear glass one preferred), then attach the short elastic hose to the stopcock *B* of the tube projecting from the stopper, and attach the other end of the same elastic

hose to the exhausting or inward-flowing chamber of the pump. Next attach one end of the longer elastic hose to the stopcock *A* projecting from the stopper, and the other end to the needle. Care should be taken that all the fittings or attachments are placed firmly into their respective places. Now close the stopcock *A* and open stopcock *B*, and by giving from thirty-five to fifty strokes of the pump a sufficient vacuum can be produced to fill with the fluid from the joint a bottle holding from a pint to a quart. After having formed the vacuum, close the stopcock *B*, and the instrument is for use. The trocar may be used to inject antiseptic agents into the part. The part is dressed antiseptically and is put at rest upon splints.

Excisions of Bones and Joints.—Excision or resection of a joint is the removal of the articular portions of the bones of the joint, and also the cartilage and synovial membrane. In the hip-joint and shoulder-joint the head of the long bone only may be removed, and not the articular surfaces of both bones. In excision enough bone is known to have been removed only when the remaining bone bleeds. Excision of a bone is the removal of an entire bone or of a portion of it. Excision is a conservative operation which often averts amputation.

Excision may be performed by the *open* method, in which the periosteum is not preserved, or it may be performed by the *subperiosteal* method, in which the periosteum is carefully separated by a rugine and the capsular ligament is preserved. *Arthrectomy*, or *erasion*, is the excision of the diseased synovial membrane and ligament, and also small foci of disease of bone and cartilage.

Excision may be employed for compound dislocation, and in compound dislocations of the elbow and the shoulder it is usually performed. Excisions for compound dislocations in other large joints are very dangerous; they are rarely attempted in battle-field practice, and are to be avoided even in civil practice unless the patient is young and vigorous and every advantage can be given him during the operation and convalescence. Excision for deformity is rarely performed except upon the hip, the knee, and the shoulder, and these excisions must not be employed if the patient's condition leads one to fear the result of a protracted convalescence. Excision of the elbow, however, is usually a safe operation. In excising for deformity always consider the patient's trade and the demands of habitual position which it makes upon him.[1]

[1] Joseph Bell, in his *Manual of Surgical Operations*.

Excision is largely employed for joint-disease, especially for tubercular joints. Bell states that attempts to preserve the limb without excision are more largely justifiable in the lower than in the upper limbs, because operation in the lower extremity is more dangerous than in the upper, and because a cure without operation in the lower limbs, if this cure can be brought about, gives as good a result as a cure by excision. In the upper extremities the danger from operation is less than is the danger from waiting. In a young subject an excision may remove the epiphysis, and thus lead to permanent shortening, which is productive of less inconvenience and deformity in the arm than in the leg. The great danger of excision operations is that the section may be made through cancellous bony tissue; hence suppuration, phlebitis, myelitis, septicemia, or pyemia may follow; further, in excision the cut is through diseased tissue, and a protracted convalescence is often inevitable. Amputation is effected through healthy tissue, and the convalescence is short. Excision, however, when successful, gives the patient a very useful limb.

Erasion, or Arthrectomy.—Erasion is the complete removal of diseased synovial membrane, ligaments, etc. This operation seeks to remove a depot of infection in an early stage of tubercular synovitis, and it possesses the conspicuous merit of not interfering with the epiphysis. Erasion is oftenest practised upon the knee-joint. The instruments required are a scalpel, hemostatic forceps, dissecting-forceps, toothed forceps, volsellum, scissors, bone-gouges, curets, and an Esmarch apparatus.

Erasion of the Knee-joint.—The patient lies upon his back; the limb is flexed with the sole of the foot planted upon the table, and an Esmarch bandage is applied at a point well up on the thigh. The surgeon stands to the right of the patient. The incision starts in the mid-line of the thigh (on the side opposite to that occupied by the surgeon), about three inches above the patella; it is carried down across the ligament of the patella and up to a corresponding point on the opposite side of the thigh. This incision is made down to the bone; the flap is turned up and the joint exposed; the knee-joint is strongly flexed, and the synovial membrane and diseased ligaments are dissected away with scissors and forceps, great care being taken that the posterior ligaments (which, fortunately, are rarely implicated early in the case) are not divided and that the contents of the popliteal space remain intact. After removing the diseased ligaments and synovial membrane examine the cartilage and remove any diseased por-

tion, and then examine the bone and gouge away any tubercular foci. Ligate any exposed vessels, irrigate the wound and dust with iodoform, straighten the extremity, suture together the ends of the ligamentum patellæ, suture the skin after inserting a drainage-tube in each angle, dust iodoform over the wound, and dress antiseptically. Put the limb upon a posterior splint for a few days, then take out the drainage-tubes, re-dress antiseptically, and put up in a plaster-of-Paris cast, cutting trap-doors upon each side and keeping the joint immobile for two or three weeks. This operation is

FIG. 203.

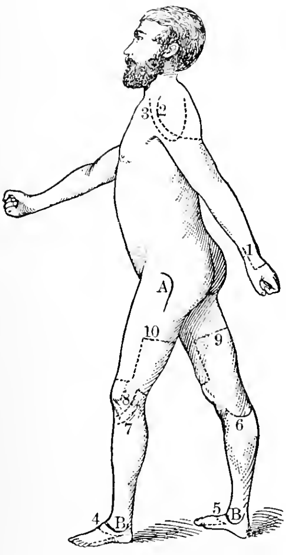


FIG. 204.

FIG. 203.—1–10, AMPUTATIONS (Joseph Bell): 1, of lower third of forearm (Teale's); 2, at shoulder-joint by large postero-external flap (second method); 3, at shoulder-joint by triangular flap from deltoid (third method); 4, 5, through tarsus (Chopart's): 6, 7, at knee-joint; 8, by single flap (Carden's); 9, 10, of thigh (Teale's). A, excision of hip; B, of ankle-joint (Hancock's incision).

FIG. 204.—1–18, AMPUTATIONS (Joseph Bell): 1, amputation at wrist-joint (dorsal incision); 2, at wrist-joint (palmar incision); 3, at forearm (dorsal incision); 4, at forearm (palmar incision); 5, at elbow-joint (anterior flap); 6, at arm (Teale's); 7, at shoulder-joint (first method); 8, 9, of metatarsus (Hey's); 10, 11, at ankle (Syme's); 12, 13, of leg, posterior flap (Lee's); 14, at knee-joint (Carden's); 15, of thigh (B. Bell's); 16, of thigh (Spence's); 17, of thigh in middle third; 18, at hip-joint. A, excision of wrist (radial incision); B, of wrist (ulnar incision).

only suited to early cases in which the lesion involves chiefly or purely the synovial membrane and ligaments, and in these cases it frequently gives a good result, some capacity for motion being not unusually preserved.

Excision of the Shoulder-joint.—In the shoulder-joint

partial excision is often performed, the head of the humerus being removed and the glenoid being undisturbed; but some patients require complete excision, the entire glenoid depression, as well as the head of the humerus, being removed by the surgeon. Excision of the shoulder-joint is made, if possible, an intracapsular operation, the capsule being

FIG. 205.

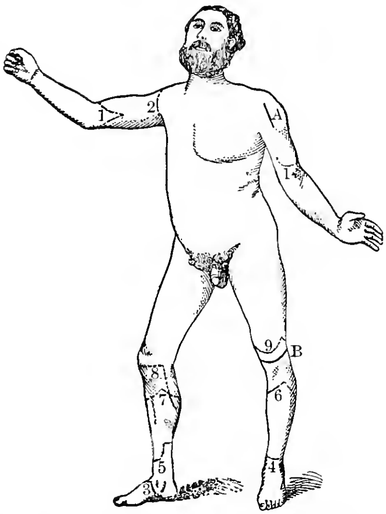


FIG. 206.

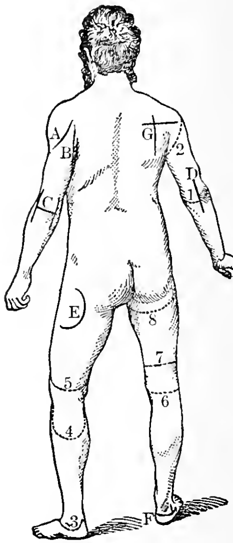


FIG. 205.—1–9, AMPUTATIONS (Joseph Bell): 1, of arm by double flaps; 2, at shoulder-joint; 3, at ankle-joint by internal flap (Mackenzie's); 4, 5, of leg just above the ankle-joint (Syme's); 6, 7, below the knee (modified circular); 8, through condyles of femur (Syme's); 9, at lower third of thigh (Syme's). A, excision of head of humerus; B, of knee-joint (semi-lunar incision).

FIG. 206.—1–8, AMPUTATIONS (Joseph Bell): 1, at elbow-joint (posterior flap); 2, at shoulder-joint, posterior incision (first method); 3, at ankle-joint (Mackenzie's); 4, through condyles of femur (Syme's); 5, at lower third of thigh (Syme's); 6, at knee (posterior incision); 7, of thigh (Spencer's); 8, at hip-joint. A–G, Excisions; A, excision of shoulder-joint (deltoid flap); B, of shoulder-joint (posterior incision); C, of elbow-joint (H-shaped incision); D, of elbow-joint (linear incision); E, of hip-joint (Gross's); F, of os calcis; G, of scapula.

opened, but the capsular attachment to the anatomical neck not being interfered with. In bad cases, however, the capsular attachment must be destroyed. This operation is rare in civil, but is common in military practice; it is performed in gunshot-wounds, in compound dislocations, in tubercular disease, and in tumors of the head and upper portion of the humerus. The instruments required are a scalpel, an Adams saw, an osteotome or chisel, a mallet, an Allis dissector, a periosteum-elevator, hemostatic forceps, dissecting-forceps, toothed forceps, lion-jawed forceps, sequestrum-forceps, metal retractors, curets, and cutting bone-forceps.

Operation by Anterior Incision.—The patient lies supine; a pillow is placed beneath the shoulders, and a sand pillow is put beneath the shoulder to be operated upon. The arm is held to the side with the outer condyle forward and the bicipital groove inward (Barker's directions). The surgeon stands by the affected side. An incision three or four inches in length is made from just external to the coracoid process, running straight down the humerus (Fig. 205, A). This incision divides the border of the deltoid muscle and brings into sight the long head of the biceps. The tendon of the biceps is retracted inward, unless it is diseased, in which case it is resected. The knife is carried up the groove and opens the capsule of the joint. The periosteum is lifted from the neck of the bone while an assistant rotates the elbow to make the muscles tense. In some places, if the periosteum tears, muscular insertions must be cut with a knife. The head of the bone is sawn off while the bone is in place, or the elbow is strongly pulled back, and the head of the bone is forced out of the wound, and is then sawn off at the point required. In ordinary cases remove only the articular head; in other cases make the section just above the surgical neck; in yet others remove a portion of the shaft. If the glenoid cavity is found slightly diseased, any dead bone must be removed by the chisel and mallet or by the cutting-forceps. If the cavity is seriously diseased, the entire glenoid should be removed. Scrape away all damaged tissue; ligate bleeding points; irrigate the wound with corrosive-sublimate solution; swab it out with a solution of chlorid of zinc (gr. xx to ℥j); dust with iodoform; close the upper portion of the wound and insert a drainage-tube in the lower angle; dress the wound antiseptically; place a small pad in the axilla; apply the second roller of Desault; and put the patient in bed with a pillow under the affected shoulder. In seven days the hand-sling is substituted for the bandage, and with the elbow hanging free the patient is permitted to get up and is advised to move his arm frequently. Drainage is maintained until the wound is well healed from the bottom. Great limitation of movement inevitably follows upon a shoulder-joint resection.

Excision by the deltoid flap is performed when the head of the bone is much enlarged (as by a tumor) or when the tissues are thick and indurated. The deltoid flap is in the shape of a V or is semilunar (Fig. 206, A). Raising this flap exposes the head of the bone most satisfactorily. Bell

states that when the glenoid cavity is chiefly involved the incision should be posterior (Fig. 206, B).

Senn's Method.—Senn has recently described[1] an incision which does not damage any important vessels, muscles, tendons, or nerves, and which is followed by good functional results. A semilunar skin-flap is formed, the incision running from the coracoid process to the posterior border of the axillary space. This flap is turned up, exposing the upper half of the deltoid muscle. The acromion is sawn off and turned down with the attached deltoid. The capsule is now freely exposed; it is opened, and either arthrectomy or excision is performed, according to conditions. In closing the wound it is not necessary to bore the acromion and pass silver wires to join the fragments; it is enough to suture the periosteum with catgut.

Excision of the Elbow-joint.—This operation is performed for wounds, faulty ankylosis, and chronic articular disease. Excision must be complete. Endeavor to make a subperiosteal resection; this maintains the shape of the articulation and gives the best chance for a movable joint. The instruments used are the same as those for the shoulder, plus a Butcher saw.

Operation.—The patient is "supine, but inclining to the sound side, the affected arm being held almost vertical, with the forearm flexed and nearly horizontal" (Barker). The incision is made on the posterior surface of the joint. A single posterior incision is usually employed (Fig. 206, D, F). An incision is made a little internal to the long axis of the olecranon, and reaching two inches above and two inches below the tip of the olecranon. This incision goes down to the bone, and throughout the entire operation the surgeon must guard and shield the ulnar nerve. The periosteum and soft parts are well separated; the olecranon is sawn off; forced flexion exposes the joint-cavity freely, and enables the surgeon to lift the periosteum and soft parts from the humerus; the humerus is sawn through at the beginning of its condyloid processes; the radius and ulna are cleared and are sawn at a level below that of the base of the coronoid process of the ulna. Cut and spoon away diseased tissues, the wound being irrigated, closed, drained, and dressed. In some cases an H-shaped incision is employed (Fig. 206, C), but the cicatrix of a transverse cut will limit flexion of the limb.

After excision of the elbow the patient is put to bed and

[1] *Phila. Med. Journ.*, Jan. 1, 1898.

the arm is laid upon a pillow, the elbow being placed midway between a right angle and complete extension, the forearm being placed midway between pronation and supination. No splint is used, as a rule. Esmarch used the splint shown in Figure 207. The aim in treatment is to obtain a freely movable joint. Passive motion is begun in one week, when the patient gets up. The hand is carried for a time in a sling.

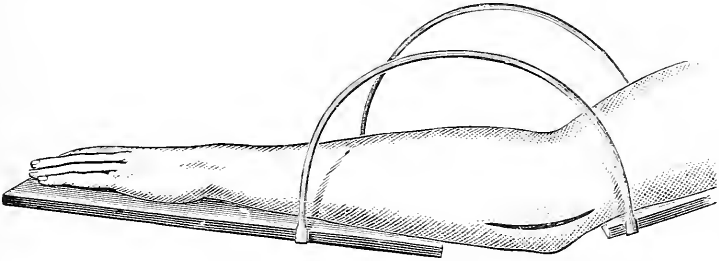


FIG. 207.—Esmarch's splint for the treatment of a limb after excision of the elbow-joint.

Excision of the Wrist-joint.—Bell states that, whatever method of excision is chosen, three cardinal rules must be borne in mind: (1) remove all the diseased bone, including the portions of the radius, ulna, carpus, and metacarpus which are covered with cartilage; (2) interfere with the tendons to the least possible degree; and (3) begin passive motion of the fingers very early. Many surgeons prefer the simple gouging away of diseased foci and the scraping of sinuses instead of a formal resection of the wrist, amputation being employed in severe cases or when scraping fails after several trials. Formal excision is not very often done, and the results cannot often be considered as very favorable.

Lister's Open Method of Excision.—The instruments required in this operation are the same as those used for any resection. Break up adhesions as completely as possible by forcible movements. Apply a tourniquet or an Esmarch apparatus. The patient lies upon his back, the arm and the forearm being brought, from stage to stage, into the most desirable positions. Begin an incision over the middle of the dorsum of the radius, on a level with the styloid process; carry it downward in the direction of the inner edge of the articulation of the thumb with its metacarpal bone, and when the knife reaches the radial side of the second metacarpal bone alter the direction of the incision and carry it downward in the long axis of the metacarpal bone to about its middle (Fig. 204, A). This is known as the *radial incision*, and the

only tendon divided is that of the extensor carpi radialis brevior muscle. The tissues upon the radial aspect of the incision are dissected up, the tendon of the extensor carpi radialis longior muscle is divided at its point of insertion (Bell), and all the soft structures are retracted outward, exposing the trapezium, which is cut off from the rest of the carpus, but which is left in place, as its removal at this stage endangers the radial artery (Barker). By extending the hand the tendons are loosened and the carpus is cleared in the direction of the ulnar border of the hand.

Another incision is made, starting upon the inner surface of the wrist, two inches above the articular surface of the ulna, and midway between the ulna and the flexor carpi ulnaris tendon. This incision, which is known as the *ulnar incision*, is carried down until it is opposite the middle of the fifth metacarpal bone in the palm (Fig. 204, B). "The dorsal lip of this incision is raised" (Bell), and the extensor carpi ulnaris tendon is divided and dissected from its depression, but is not separated from the integument. The extensor tendons are lifted; the ligaments upon the dorsum and sides of the wrist-joint are cut; the flexor tendons are raised from the carpal bones; the pisiform bone is cut from the carpus, but is not yet removed; and the unciform process of the unciform bone is cut with forceps. The anterior radio-carpal ligament is divided, the carpometacarpal articulations are cut through, and the carpus is pulled out with bone-forceps. The ends of the radius and ulna are forced out of the ulnar incision. All that portion of the ulna which is crusted with cartilage is to be removed, the saw-cut is to be oblique, and the base of the styloid process is to be left behind. A thin section is to be sawn from the radius, and the tendon-grooves are not to be impinged upon. The articular surface of the ulna is cut away with pliers (Bell). If foci of disease are discovered beyond these points, they are to be gouged out. The ends of the metacarpal bones are sawn off, and their articular facets are cut away by means of pliers. The trapezium is dissected out, the end of the first metacarpal bone is sawn off and its facet is cut away with pliers, and a portion of the pisiform bone is removed (the entire bone being removed if it be diseased). The wound is irrigated, vessels are tied, the radial incision is closed, the ulnar incision is partly closed, a drainage-tube is inserted by way of the ulnar incision, the wounds are dressed antiseptically, and the Esmarch apparatus is taken off. The forearm and hand are placed upon a splint which

immobilizes the wrist and leaves the fingers semiflexed. The splint is worn for many months, until the wrist-joint is immobile and solid. Esmarch uses the splint shown in Fig. 208.

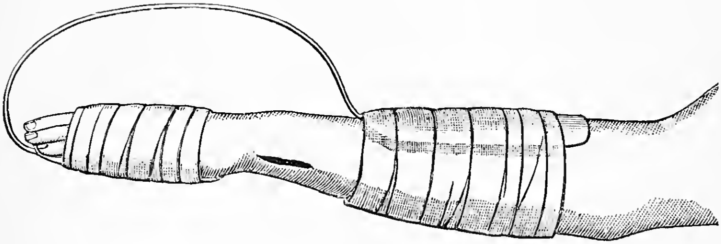


FIG. 208.—Esmarch's interrupted splint applied.

Passive motion of the fingers is begun after thirty-six hours.

Excision of Metacarpal Bones and of Phalanges.—Excision of a metacarpal bone, except in cases of necrosis with the formation of large quantities of new bone, usually leaves a useless finger; hence amputation is preferred usually to excision. This rule does not apply to the metacarpal bone of the thumb, which is occasionally resected. The incision for this operation is made upon the dorsum, and is straight. Excision of the proximal phalanx of the thumb is sometimes performed. Excision for disease is rarely performed upon the finger-joints, amputation being preferred, though the operation is sometimes undertaken for compound dislocation. In the metacarpophalangeal joint of the thumb excision, if it can be performed, is preferred to amputation. The incision for resection of this joint is placed upon the radial aspect.

Excision of the Hip-joint.—Some surgeons advocate this operation; others, notably Marsh, are emphatically opposed to it. Excision should be performed in the early stage of tubercular disease *if less radical treatment has failed*, and in this stage the usual position of the limb is one of flexion, abduction, and eversion. In cases of long duration, especially where dislocation exists, excision is an easy and a comparatively safe operation; in recent cases it is difficult and carries with it decided dangers, but the peril of delay may be greater than the peril of an early resection. In cases of hip disease with involvement of the acetabulum the mortality is 50 per cent., whether operation is or is not attempted. Excision is performed especially for tubercular

disease and for gunshot-injuries. The instruments required are those used for other excisions.

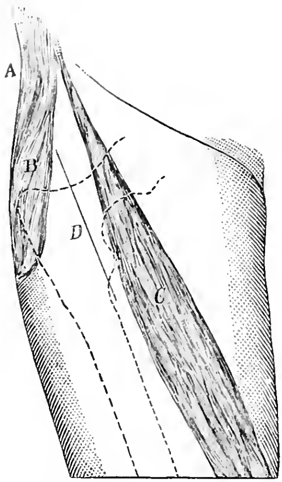


FIG. 209.—Excision of the hip-joint: A, gluteus muscle; B, tensor vaginæ femoris muscle; C, sartorius muscle; D, anterior incision.

Operation by Anterior Incision (Fig. 209) (Parker's Operation).—In this operation the patient is supine, with the thighs extended as thoroughly as circumstances permit. The surgeon stands to the right of the patient. An incision is begun half an inch below and half an inch external to the anterior superior iliac spine, and it is carried downward and a little inward for about three inches (Fig. 209, D). If dislocation exists, the incision must not be so long. This incision is carried at once deeply between the muscles, and the capsule of the joint is opened. The neck of the bone is divided from its upper surface downward with a saw or an osteotome, and without dislocating the bone through the wound by forcible extension and eversion, the head of the bone is removed. All tubercular foci must be scraped away, and the flushing gouge is used upon tubercular areas of the acetabulum. All sinuses should be thoroughly scraped. Bleeding is arrested, the wound is irrigated with corrosive-sublimate solution, mopped out with chlorid-of-zinc solution, and dusted with iodoform. A drainage-tube is inserted at the lower angle of the incision, and the upper portion of the cut is closed. The wound is dressed antiseptically. Extension is made with the extension apparatus until healing has obtained a good headway, when a double Thomas's splint is applied, so that the patient can be taken out daily in the air and sunlight. As a rule, rigid ankylosis results from resection of the hip, but occasionally a joint results with a small range of movement.

Operation by Lateral Incision (Langenbeck's Operation).—In this operation a straight incision two inches long is made in the direction of the axis of the femur, and runs downward from the apex of the great trochanter. From the beginning of this incision a curved incision is carried toward the head of the bone, the convexity of the curve being backward

(Fig. 203, A). Bell advises the use of the saw after bringing the head of the bone into the wound by abduction and eversion of the thigh. Barker applies the saw with the bone *in situ*, and strongly opposes wrenching the bone out of the incision, because of the danger of peeling off the periosteum, which peeling, if it takes place, favors necrosis.

Incision of Gross.—In Gross's operation a semilunar flap is made with the convexity backward (Fig. 206, E).

Excision of the Knee-joint.—In this operation a complete excision should be performed, and the patella ought to be removed. This operation is performed in tubercular disease, in some compound fractures and compound dislocations, and in some cases of angular ankylosis, but it is rarely employed for gunshot-injuries, amputation being advisable (Ashhurst). The instruments required are the same as those for the shoulder, plus Butcher's saw.

Operation by Anterior Semilunar Flap.—The patient lies upon his back, and the joint, if not ankylosed in extension, is semiflexed. The surgeon stands to the right side. An incision is made, at once opening the joint, starting from one condyle and reaching the other condyle by a downward curve which passes through the ligamentum patellæ midway between the tuberosity of the tibia and the inferior margin of the patella (Fig. 205, B). The flap is dissected up, the knee is thrown into forced flexion, the lateral ligaments and crucial ligaments are cut, and the end of the femur is well cleared. The blade of Butcher's saw is passed beneath the bone, which is sawn from below upward (Ashhurst). The end of the tibia is cleared and a portion is sawn off. If, after sawing, diseased foci are discovered, another section can be sawn off or the foci can be gouged away. Ashhurst, who has had a vast experience with this operation, insists that in sawing through the femur the natural obliquity of the bone must be borne in mind and the section must be made in "a line parallel to that of the free surface of the condyles." If the section is made transverse to the axis of the femur, "the limb, after adjustment, will be found to be markedly bowed outward." The same surgeon says that the epiphyseal line is somewhat higher on the front than it is on the back of the femur, and in consequence the following rule is formulated for section of the condyles: the section of the condyles should be "in a plane which, as regards the axis of the femur, is oblique from behind forward, from below upward, and from within outward." Ashhurst advocates section of the tibia "in a plane transverse to the long axis of the bone, with a slight anteroposte-

rior obliquity, so as to correspond with that of the section of the condyles," and further says also that the patella must be removed, whether it is diseased or not, and he quotes Péniére's observations to the effect that excision of the patella diminishes the risk of death one-third, and its retention doubles the probability of an amputation becoming necessary in the future.

After removing the patella the diseased synovial membrane is clipped away with scissors and all sinuses and diseased territories are well curetted. The posterior ligament of the joint is not removed unless it is diseased; its retention prevents displacement and guards the popliteal space. In children the fragments should be wired together; in adults this need not be done. After hemostasis irrigate, dust with iodoform, insert a drainage-tube, suture, dress antiseptically, and adjust the limb upon Price's splint or Ashhurst's bracketed wire splint. In some cases tenotomy is required to permit extension. Instead of the bracketed splint, a long fracture-box may be used. If the femur tends to project anteriorly, use an anterior splint. If there be a tendency to outward bowing, adopt Ashhurst's expedient of carrying a strip of adhesive plaster around the outside of the limb and fastening it to the inner side of the splint. The splint is kept on until bony union is complete, as in this operation a movable joint is never sought. Many surgeons use a plaster-of-Paris splint, which is employed until the parts have become firm and solid (Fig. 210).

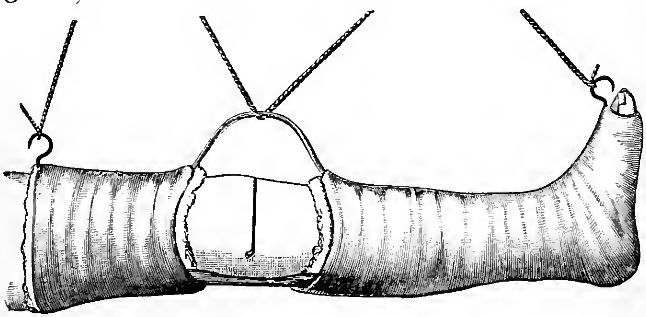


Fig. 210.—Watson's plaster-of-Paris swing-splint.

Excision of the Ankle-joint.—This operation is performed chiefly in gunshot-wounds, in compound dislocations, and in early cases of chronic joint-disease. Complete resection is employed for chronic joint-disease. Excision of the ankle is a rare operation. The instruments used are the same as those employed for any resection.

Operation (Hancock's Method).—In this operation the patient lies upon his back, the foot rests upon its inner side, and the surgeon stands to the outer side of the damaged limb. Begin an incision just behind and two inches above the external malleolus, and carry it across the front of the joint to a corresponding point above and behind the internal malleolus (Fig. 203, B); this incision goes only through the skin, and the flap thus marked out is reflected. "Cut down upon the external malleolus, carrying the knife close to the edge of the bone both behind and below the process, dislodge the peronei tendons, and divide the external lateral ligaments" (Joseph Bell). Cut the fibula one inch above the malleolus by means of pliers; divide the tibiofibular ligament; turn the foot upon its outer side; dissect from their habitat back of the inner malleolus the tendons of the posterior tibial and the common flexor of the toes; carry the knife around the inner malleolus, close to the bony edge; separate the internal lateral ligament, and dislocate the lower end of the tibia through the wound by turning the sole of the foot downward; saw off the lower end of the tibia and the articular process of the astragalus, sawing away from the tendo Achillis, and remove the fragments with bone-forceps. Cut away diseased synovial membrane, and curet all sinuses and tubercular areas. Arrest bleeding, irrigate, and drain. Sew up the wound, insert a tube at the outer angle, and cause it to emerge at the inner angle. Apply antiseptic dressings, and put up the foot in fixed dressing or in splints at a right angle to the leg (Fig. 211). In Langenbeck's operation the excision is subperios-

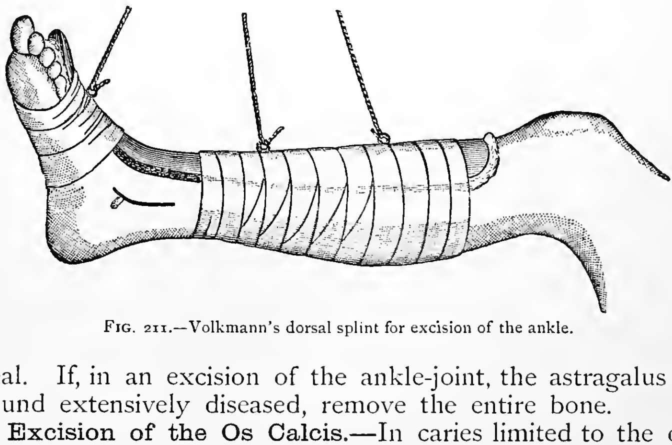


FIG. 211.—Volkmann's dorsal splint for excision of the ankle.

teal. If, in an excision of the ankle-joint, the astragalus is found extensively diseased, remove the entire bone.

Excision of the Os Calcis.—In caries limited to the os

calcis most surgeons prefer to gouge away the dead bone, leaving the periosteum and, if possible, a shell of healthy bone, and draining thoroughly. Others advocate excision in some cases. Extensive disease limited purely to the os calcis is rare, and most surgeons advise gouging for limited caries, and Syme's amputation in the event of the disease extending beyond the periosteum or reaching adjacent bones.

Operation by Subperiosteal Method.—In this operation the position assumed by the patient is supine with the leg extended and the foot resting on its inner side. The incision, which cuts the tendo Achillis and reaches the bone at once, is begun at the upper border of the os calcis and the inner margin of the tendo Achillis, and is taken outward and horizontally forward to a point in front of the calcaneocuboid articulation. A vertical incision is begun near the forward termination of the initial incision, is carried across the outer edge and plantar surface of the foot, and terminates at the external margin of the inner surface of the os calcis. Some surgeons carry the vertical incision a little upward, toward the dorsum (Fig. 206, F). The periosteum is entirely stripped with an elevator, the os calcis is removed, the cavity is packed with iodoform gauze, the wound is stitched, a drain is inserted posteriorly, and the foot is dressed antiseptically and put up in plaster at a right angle to the leg, trap-doors being cut for drainage.

Excision of the astragalus is a rare operation.

Operation by the Subperiosteal Plan.—Barker advises an incision going at once to the bone, from the "tip of the external malleolus forward and a little inward, curving toward the dorsum of the foot." The foot is extended and turned inward, the periosteum is lifted, the bone is removed, and the wound is treated and the foot is dressed as is done in excision of the os calcis.

Excision of the Metatarsophalangeal Articulation of the Great Toe.—In this operation make a lateral incision and cut off or saw off the proximal end of the first phalanx and the distal third of the first metatarsal bone.

Excision of the Metatarsal Bone of the Great Toe (Butcher's Method).—In this operation a lateral straight incision is made, the periosteum is elevated, and the shaft is sawn from each extremity and removed.

Excision of the clavicle may be required in dislocation, in caries, in necrosis, for gunshot-wounds, in tumor of this bone, as a preliminary to ligation of the artery and vein in certain cases of amputation at the shoulder-joint, or in cases

of removal of the entire upper extremity. In excision of the clavicle the position of the patient is the same as that for ligation of the third part of the subclavian artery (page 366). An incision is made down to the bone, from the sternoclavicular joint to the acromioclavicular articulation. If the case is suitable, the periosteum is stripped and the bone is sawn and removed; if not, the bone is sawn and each half is separately disarticulated. The wound is sutured and dressed, and the limb is put up in a Velpeau bandage.

Excision of the Scapula.—Complete excision of the scapula is most usually performed for tumors. Partial excision requires no detailed description. In excision of the scapula the patient lies upon his sound side. Treves suggests the following incisions: one outside the vertebral border of the scapula, from its superior to its inferior angle; another from over the acromioclavicular joint, along the acromion process and spine of the scapula, to meet the first incision. Syme used an incision carried transversely inward from the acromion process to the vertebral border of the scapula, and another cut directly downward from the center of the first incision (Fig. 206, G). In the method of Treves[1] the upper flap is reflected and the trapezius muscle is divided; the lower flap is reflected and the deltoid muscle is divided. The patient's hand is placed on the sound shoulder; the muscles of the vertebral border are divided, the posterior scapular artery is tied, and while the vertebral border of the scapula is pulled toward the surgeon the serratus magnus muscle is cut, the upper border of the shoulder-blade is cleared, and the suprascapular artery is tied. The hand is now brought down to the side; the acromioclavicular joint is disarticulated; the conoid and trapezoid ligaments are divided; the muscles of the coracoid process are cut; the capsule is incised, with the supraspinatus and infraspinatus, the subscapularis muscles, and the scapular origins of the biceps and triceps; and finally the teres major and minor muscles are divided, the subscapular artery is tied, and the bone is removed. The wound is stitched, a drain is introduced, and antiseptic dressings are applied. The patient lies upon his back until healing is well under way, when the arm is placed in a sling. The drainage-tube may be removed in twenty-four hours.

Excision of a Rib.—In caries the gouge and rongeur may remove the disease. In other cases excision is performed. In this operation the patient lies upon his sound side. The

[1] Treves's *Manual of Operative Surgery.*

surgeon faces the patient. Make an incision down to the bone, in the long axis of the rib. The periosteum, if not diseased, is lifted from the bone, and the intercostal artery is thus saved from being cut. After sawing the bone beyond the limits of disease, remove it. During the sawing a metal retractor is held beneath the rib, between the rib and the periosteum. If the periosteum is diseased, remove it after tying the intercostal artery. Curet sinuses. Pack with iodoform gauze for some days. Sew up the wound except at one end. Dress antiseptically and apply a binder. If a rib is resected in order to drain the pleural cavity, remove it by the subperiosteal section, ligate the artery after a portion of the rib has been removed, cut away the periosteum to prevent re-formation of bone, and open the pleura. (See Operations upon the Chest and Estlander's Operation.)

Complete Excision of One-half of the Upper Jaw.—The whole upper jaw has been removed, but in what follows only resection of one-half the jaw will be described. This operation is performed for malignant tumors of the superior maxillary bone or its antrum. Up to 1826, at which time Lizars of Edinburgh suggested the operation, tumors of the antrum were treated by scraping them away with a sharp spoon. Gensoul of Lyons in 1827 performed the first operation for resection of the upper jaw. This operation is not justifiable, except as a palliative measure, if the orbit is invaded, if the skin and subcutaneous tissues are infiltrated, or if the disease extends beyond the superior maxillary and palate bones. The instruments required are a mouth-gag; scalpels; strong scissors; dissecting, toothed, and hemostatic forceps; bone-cutting forceps; lion-jaw and sequestrum-forceps; tooth-extracting forceps; a volsella; a narrow-bladed saw; a chisel and mallet; a periosteum-elevator; a spatula or metal retractor; Paquelin's cautery; sponges which are tied to sticks; needles, curved and straight; silk and catgut ligatures; silkworm-sutures; large curved needles; and Horsley's antiseptic bone-wax.

Operation by Median Incision.—The patient, whose face has been shaved, is placed in the Trendelenburg position, thus avoiding the possible need of instant tracheotomy. The surgeon stands to the right side of, and faces, the patient. The incisor tooth on the diseased side is pulled out. The incision (Fig. 212, line A B) is begun half an inch below the inner canthus of the eye, and is carried along the side of the nose, around the ala of the nose, by the margin of the nostril, and through the middle of the lip. While

the lip is being incised the assistant arrests hemorrhage by grasping the corners of the mouth, and after the lip is divided the coronary arteries are at once ligated. Some operators approach the mucous membrane cautiously and ligate the vessels before opening the cavity of the mouth. The upper portion of the wound having been compressed by another assistant during these manipulations, pressure is now removed and bleeding points are ligated. Another incision is now carried outward from the beginning of the first incision, along the orbital margin to well over the malar bone. The flap is lifted from the periosteum, and the bleeding from the infraorbital artery and the small vessels is restrained by pressure. The nasal cartilage is separated from the bone, and the nasal process of the superior maxillary is sawn (line A B, Fig. 213). The orbital periosteum is lifted up, and the orbital plate is cut with forceps from the saw-cut in the superior maxillary bone to the sphenomaxillary fissure (line B C, Fig. 213). The malar bone is sawn or is bitten through about its center, the cut running into the sphenomaxillary fissure and taking a downward and outward direction (line C D, Fig. 213). The soft parts covering the hard palate are incised in the median line, a corresponding incision is made along the floor of the nose near the septum, and the soft palate is separated from the hard palate by a transverse cut. The saw is introduced through the nose, and the palate is sawn (line E, Fig. 213). The upper jaw-bone is grasped with Fergusson's lion-jaw forceps and removed, the removal being aided by the use of the scissors and bone-cutters; the latter are used to separate the upper jaw from the pterygoid process (Treves). Every vessel that can be

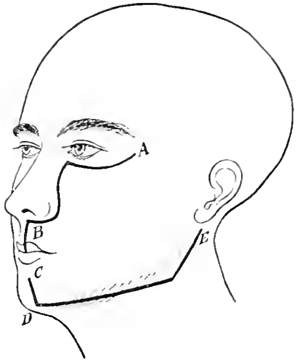


FIG. 212.—A B, excision of the upper jaw; C D E, excision of the lower jaw.

FIG. 213.—1. Excision of the upper jaw: A B, section of the nasal process; B C, section of the orbital plate; D, section of the malar bone and orbital plate; E, section of the alveolus, and hard palate. 2. Excision of the lower jaw: G, section of the inferior maxillary; H, section of the ramus in partial resection.

seen is tied, and severe bleeding from bone is arrested by antiseptic wax. Oozing is controlled by hot water and pressure or by Paquelin's cautery. Examine carefully to see if all the diseased area is removed; if it is not, use the gouge, scissors, chisel, and saw until healthy tissue is reached. The wound is packed with iodoform gauze, and the end of the strip is so placed as to be accessible through the mouth. The wound is sutured (the mucous membrane of the lip must be stitched, as well as the skin) and is dressed antiseptically (the eye being protected by aseptic gauze), and a crossed bandage of the angle of the jaw is applied.

Excision of One-half of the Lower Jaw.—In some rare instances the entire inferior maxillary bone is removed. The lesions necessitating removal of the lower jaw are of the same nature as cause us to remove the upper jaw. The instruments required for removal of the lower jaw are those used for excision of the upper jaw, plus a metacarpal saw (having a movable back).

In this operation the patient is placed in the same position as for excision of the upper jaw, the chin having been previously shaved. A vertical cut is made through the chin-tissue, starting below the margin of the lip and reaching to below the border of the jaw (C D, Fig. 212). From the point D an incision is carried outward below the border of the jaw and then back of the ramus, as shown in the line D E (Fig. 212). Treves's advice is to carry this incision down to the bone, except at the line of the facial artery, at which point it must go through the skin only. The facial artery is now to be sought for, tied in two places, and divided. The periosteum is lifted from the external surface of the bone, from the symphysis outward. Hemorrhage is arrested. The buccal mucous membrane is cut from the alveolus. A lateral incisor tooth is pulled, and the bone is sawn in the line G (Fig. 213). The bone is grasped in a lion-jaw forceps and is drawn outward. The mylohyoid insertion is cut; the internal pterygoid muscle is cut or the periosteum at this spot is lifted; the inferior dental artery is cut and tied; the jaw is pulled down; the insertion of the temporal muscle upon the coronoid process is cut away; and the external pterygoid muscle is divided. The capsule of the joint is opened, and the bone is separated from the ligaments which still hold it in place. Bleeding is arrested, the wound is sutured, a tube is introduced in the posterior portion of the wound and retained for twenty-four hours, and antiseptic dressings and

a Gibson or a Barton bandage are applied. Partial excisions of the alveolus may be performed through the mouth by means of chisels and rongeur forceps, and Wyeth has removed half of the jaw by this method; but if any considerable part of the body of the jaw is to be removed, it is usually best to make an incision below the jaw.

Operation for Congenital Dislocation of Hip.—*Hoffa's Operation.*—The instruments used are the same as for a resection. Make the external incision of Langenbeck to open the joint (page 604). The capsule is incised at its insertion into the neck, and the periosteum and muscles are lifted from the great trochanter. Hoffa claims that in children less than five years of age the head can be readily replaced into the acetabulum by flexing the thigh and making direct pressure upon the head of the bone. After replacing the head it is held in place while an assistant extends the leg in order to stretch the muscles. In children over five years of age cut the muscles which spring from the ischial tuberosity and also the adductors with a tenotome; cut the fascia lata and muscles which arise from the anterior superior iliac spine by incision; open the joint and liberate the head; remove the ligamentum teres; scrape out the acetabulum, removing "cartilage, fat, and considerable spongy tissue" (Tubby); and replace the head in the acetabulum. The limb is maintained in inversion, abduction, and extension for several weeks, when it is straightened. Massage and passive motion are begun in the fifth week. The patient now gets about, wearing an apparatus for many weeks. This apparatus permits the head of the bone to move in the socket, but prevents redislocation.

Lorenz's Operation.—This is a modification of Hoffa's. The muscles inserted into the greater trochanter and the lesser trochanter are not cut; the sartorius, the hamstrings, and the external portion of the fascia lata are cut (Tubby).

The incision of Lorenz is longitudinally from the anterior superior spine. Another incision is carried inward from this at the level of the lesser trochanter. The capsule is opened by a crucial cut; the acetabulum is enlarged; the head of the bone, if it remains, is inserted into the acetabulum; if there is no true head, a new one is formed and inserted into the cavity. The limb is immobilized in a position of moderate abduction. Massage and passive motion are begun in the fifth week, and are continued for months.[1]

[1] I have drawn from the very lucid description of these operations in A. H. Tubby's treatise upon "Deformities."

XX. DISEASES AND INJURIES OF MUSCLES, TENDONS, AND BURSÆ.

Myalgia, or **muscular rheumatism,** is a painful disorder of the voluntary muscles and of the fibrous and periosteal areas where they are attached. The term "muscular rheumatism" is not strictly correct. It is possible that in some cases the muscular structure is inflamed, but it is certain that in many cases the pain is distinctly neuralgic. Muscular rheumatism may be due to cold and wet, to overexertion and strain, to acute infectious disorders, to syphilis, to chronic intoxications (lead, mercury, and alcohol), and to disturbances of the circulation. Gouty and rheumatic persons are especially predisposed, men being more liable to the disease than women. The disease is usually acute, but it may be chronic.

Symptoms.—Muscular rheumatism is apt to come on suddenly. The pain, which may be very acute and lancinating or may be dull and aching, is in some cases constantly present; in other cases it is awakened only by muscular contraction. The pain is frequently relieved by pressure, though there is often some soreness. The skin above the muscle is sometimes tender to light pressure. The disease usually lasts for a few days, but it tends to recur. There is little, if any, fever.

Lumbago is myalgia of the muscles of the loins. *Rheumatic torticollis* is myalgia of the muscles of the neck. Usually one side of the neck is attacked. The chin is turned from the affected side and the neck is stiff. *Pleurodynia* is myalgia of the intercostal muscles. The pain is very severe, is aggravated by deep respiration, by coughing, and by yawning, there may be tenderness, and the patient tries to limit chest-movement. In *intercostal neuralgia* the pain is limited, is not constant, but occurs in distinct paroxysms, and is linked with the presence of the tender spots of Valleix. Pleurodynia lacks the physical signs of pleurisy. Myalgia must not be confused with the pains of locomotor ataxia. *Cephalodynia* is myalgia of the muscles of the scalp. The muscles of the shoulder, upper dorsal region, abdomen, and extremities may also be attacked by myalgia.

Treatment.—Remove any obvious cause. Treat any existing diathesis, such as gout or rheumatism. Rest is of the first importance. For lumbago, put the person to bed. For pleurodynia, strap the side of the chest. A hypodermatic injection of morphin and atropin into the affected muscles at

once allays the pain, and a deep injection of distilled water is sometimes curative. The introduction of four or five aseptic needles into the muscles, and their retention for a few minutes, sometimes act most favorably. Ironing the skin above the painful muscles is a useful domestic remedy. Vigorous rubbing of the area with a piece of ice allays the pain. Hot poultices do good. If the pain is widely diffused, alters its seat, or is very obstinate, order hot baths or Turkish baths and administer diuretics. In chronic cases employ blisters or counter-irritation by the cautery, give iodid of potassium and nux vomica, and have the patient take a Turkish bath every week. The constant electric current finds advocates. In an ordinary severe case order a hot bath, put the patient to bed with a hot-water bag over the part, and administer 10 grains of Dover's powder; the next morning order to be taken four times daily a capsule containing 5 grains of salol and 3 grains of phenacetin, until the pain disappears. Citrate of potassium, citrate of lithium, chlorid of ammonium, or the salicylate of colchicin may be ordered.

Infective myositis is a widespread inflammation of the voluntary muscles, due to an unknown infective cause. It is a disorder accompanied by pain and stiffness, by cutaneous edema, and by various paresthesiæ. Myositis resembles trichinosis, and is distinguished from it only by spearing out a bit of muscle and examining it microscopically. Occasionally diffuse suppuration occurs. Ordinary myositis arises from injuries, from syphilis, or from rheumatism, and it presents the usual inflammatory symptoms. Contraction and adhesions may follow.

Treatment.—Infective myositis is treated by anodynes, stimulants, nutritious food, hot applications, and rest. If pus forms, it should be evacuated. Rheumatic myositis calls for the administration of the salicylates, the alkalies, or salol. Syphilitic myositis is treated with mercury and iodid of potassium. The remedies employed for myalgia are used in traumatic myositis.

Hypertrophy of the muscles may arise from their increased use. In pseudohypertrophic paralysis the bulk of the muscle is greatly augmented, but it contains less muscle-structure and more fat or connective tissue.

Atrophy of the muscles arises from want of use, from injury, from continuous pressure, from interference with the blood-supply, from disease of the nerves or their centers, or from lead-poisoning.

Degeneration of Muscles.—The muscles may undergo

granular degeneration, waxy degeneration, fatty degeneration, and calcareous degeneration, and may become pigmented.

Local Ossification and Myositis Ossificans.—It is not unusual for a small portion of bone to form in the periosteal insertion of a muscle which is subjected to frequent strain. In persons who ride many hours a day there not infrequently develops the "rider's bone," which is an area of ossification in the adductor muscles of the thigh. *Myositis ossificans*, a widespread ossification of the muscles, is a rare disorder the cause of which is unknown, and which if not congenital begins at least in early life.

Tumors of the Muscles.—Primary tumors of the muscles are rare. Among those which may occur are sarcoma, fibroma, lipoma, osteoma, angioma, myxoma, and enchondroma. Most cases of supposed primary sarcoma of muscle are in reality cases of syphiloma (Esmarch).

Syphilis may cause inflammation. Gummata may form, or gummatous infiltration may take place.

Trichinosis or **trichiniasis** is a disease due to the embryos of the trichina spiralis. The disease originates from eating insufficiently cooked meat which contains the trichinæ. These nematodes are carried into the intestine, there to develop and multiply. In from seven to nine days a horde of embryos develop in the bowel, and leave the alimentary canal by passing through the peritoneum or by means of the blood, and finally reach the connective tissue of the muscles. From the connective tissue the embryos migrate into the primitive muscle-fibers, where they dwell and enlarge. Myositis develops, and in the course of five or six weeks the parasites become encapsuled and develop no further. The cyst-walls may calcify and the worms may become calcified, or may live for years. Because infected meat is eaten the disease does not inevitably develop, and a few embryos lodged in muscle may cause no symptoms.

Symptoms.—The symptoms of trichinosis often appear in a day or two after eating infected meat. The symptoms of acute gastro-intestinal catarrh or of cholera morbus are common, but in some cases no gastro-intestinal manifestations usher in the disease. In from seven to fourteen days after the infected meat is eaten the migration of the parasites develops obvious symptoms. A chill may be noted; there is usually fever; muscular pain, tenderness, swelling, and stiffness are complained of. This condition may be widespread. Involve-

ment of the muscles of mastication interferes with chewing; of the larynx, with audition and respiration; of the intercostals and diaphragm, with respiration. Skin-edema and itching are marked. In some cases delirium exists. The writer saw in the Philadelphia Hospital one fatal case which was mistaken for erysipelas because of the high fever, the delirium, and the edematous redness of the face and neck. Dyspnea is frequent. Mild cases get well in a week or two; severe cases may last many weeks. The mortality varies in different epidemics from 1 to 30 per cent. (Osler). The diagnosis is made by spearing out a piece of muscle, which is then examined for trichinæ under a microscope; or the worm may be detected in the feces by means of a pocket-lens.

Treatment.—To treat trichinosis employ purgatives (senna and calomel) early in the case, and give glycerin, and also santonin or filix mas. When muscular invasion has taken place, sedatives, hypnotics, nourishing diet, and stimulants are indicated.

Wounds and Contusions of the Muscles.—*Wounds* of muscles may be either *open* or *subcutaneous*. In a longitudinal wound the edges lie close together, and hence drainage must be provided for by the surgeon. In a transverse wound the edges separate widely, and catgut stitches must be inserted. *Contusions* of muscles, like contusions of other tissues, vary in extent and in severity. There are pain (which is increased by attempts to use the muscle), loss of function, swelling beneath the deep fascia, and discoloration, which may appear at once because of superficial damage from the initial injury, or which may appear in dependent parts after many days by gravitation of the blood and the blood-stained serum. As a result of contusion, suppuration, inflammation, or atrophy may arise.

Treatment.—The indications in wounds and contusions of muscles are to obtain rest by means of splints and to secure relaxation. Limitation of swelling is secured by bandaging. Inflammation is combated first by cold and lead-water and laudanum; later by iodin, blue ointment, ichthyol, and intermittent heat. To prevent loss of function employ, as soon as the acute symptoms subside, massage, passive motion, and stimulating liniments, and, later in the case, electricity (galvanism if the reactions of degeneration exist, faradism if they are absent).

Strains and Ruptures.—A strain is a stretching of a muscle with a small amount of rupture. The muscle is

swollen, tender, stiff, weak, and sore, and attempts at motion produce sharp pain. Strains are common in the deltoid, the hamstring muscles, the back, the calf, the biceps, and the great pectoral. Strain of the psoas muscle causes pain on flexing the thigh, and is associated with tenderness in the iliac fossa. Strain of the right psoas may be mistaken for appendicitis, but it lacks the intense local tenderness, the abdominal rigidity, and the constitutional symptoms. "Lawn-tennis arm" is a strain of the pronator radii teres muscle. "Riders' leg" is a strain of the adductor muscles of the thigh. A strain may be the only injury, or may be associated with some other condition (fracture of bone, dislocation, sprain, contusion, etc.). A strain may be followed by periostitis at the point of insertion of the muscle.

The muscle is often rigid, is tender, and pains greatly when an attempt is made to use it. The skin over it, especially over its point of insertion, is usually tender.

A strain of the back is a very common accident which is often associated with sprains of the vertebral ligaments. There is great pain when the patient voluntarily straightens up. If the vertebral ligaments are not sprained, the patient can be straightened by passive motion without pain. The skin is tender in certain areas. The muscles are often rigid. There may be unilateral rigidity. In a back injury make a careful examination to be sure there is no damage to vertebræ or cord.

Treatment.—Relaxation by suitable position; rest by the use of splints or by putting the patient to bed; bandages for compression; hot fomentations or a hot-water bag, or ichthyol. As soon as acute symptoms subside employ frictions and massage. If there is much pain after a strain, administer Dover's powder, or even morphin.

Rupture of a muscle is announced by a sudden and violent pain and by loss of function arising during powerful muscular contraction or strong traction on a muscle. The rupture may be announced by a clearly audible snap (A. Pearce Gould). A distinct gap is felt between the ends; great pain develops on movement; there are tenderness, loss of power, and swelling. Strains and ruptures may be followed by atrophy, as are contusions. Among the muscles which occasionally rupture we may mention the quadriceps, biceps, triceps, deltoid, plantaris, etc.

Treatment.—In limited rupture treat as a severe strain. In treating extensive rupture of an important muscle, when the ends are widely separated, incise with every aseptic

care, unite the divided ends with sutures of chromic catgut, and sew up the skin with silkworm-gut. Treat the part in any case by rest and relaxation, and combat inflammation by appropriate means. Passive motion and massage are employed as soon as union is firm. In rupture of the quadriceps extensor femoris, operation should be undertaken, because mechanical treatment gives frequently a bad result and confines the patient to bed for many weeks.

Hernia of Muscles.—When a tear takes place in a muscular sheath a portion of the muscle protrudes. The **treatment** is incision and the stitching of the sheath.

Contractions of muscles may result from injury, from joint-disease, from malposition of parts (as in old dislocation or torticollis), or from diseases of the nervous system. The **treatment** in some cases is sudden extension, in other cases gradual extension, tenotomy, or myotomy. Macewen recommends the making of a number of V-shaped incisions in the muscle. In some cases of spasmodic contraction nerve-stretching is of value.

Dislocation of Muscles and Tendons.—The long head of the biceps is oftenest displaced. The flexor carpi ulnaris, the peroneus brevis, the peroneus longus, the tibialis posticus, the sartorius, the plantaris, the quadriceps extensor femoris, and the extensors back of the wrist may be dislocated. What is known as dislocation of the latissimus dorsi, a condition in which that muscle no longer lies upon the angle of the scapula, is not a dislocation, but a paralysis. Most of these accidents are associated with chronic joint-disease or with fracture, but displacement may exist as a solitary injury. Dislocation of the long head of the biceps may occur tolerably early in the progress of rheumatoid arthritis of the shoulder-joint, and the displaced tendon may be absorbed.

Symptoms.—After dislocation of a tendon the muscle of the tendon can still contract, but it acts at a disadvantage; thus the corresponding joint exhibits partial loss of function. The displaced tendon can be felt, and a hollow exists where it normally resides.

When the muscle contracts the tendon is felt to slip from its groove. When the tendon of the biceps is dislocated the head of the bone passes forward (so-called subluxation of the humerus).

Treatment.—In tendon-dislocation reduction is easy, but the displacement is apt to recur because of laceration of the sheath. The treatment usually advised is to effect reduction

by relaxation of the limb and manipulation of the tendon, to place the part upon a splint so that the muscle belonging to the tendon will be relaxed, and to apply pressure over the point of injury. This treatment generally fails, and if the tendon does not become anchored in its proper situation firmly in four weeks we should operate. In some tendons it is enough to incise, freshen the edges of the torn sheath, and sew up with kangaroo-tendon or chromic catgut. In a tendon lying in a long groove, make a halter for the tendon by incising the periosteum and suturing it over the tendon.[1] Passive movements are begun at the end of the first week. Even if the tendon will not remain reduced, a useful joint will be obtained. Wood of New York advised in obstinate cases tenotomy and immobilization.

Wounds of Tendons.—Subcutaneous wounds of tendons are usually inflicted by the surgeon, and they heal well. Open wounds require rigid antisepsis and suturing of the tendon. In wounds of the wrist especially always suture the tendons (Fig. 218), and be sure to bring the proper ends into apposition.

Rupture of Tendons.—A violent muscular effort may rupture a tendon, and as the accident occurs a snap may often be heard. The **symptoms** are sudden pain and loss of power, fulness of the associated muscle from retraction, and absolute inability to bring the tendon into action. A gap may often be felt in the tendon.

Treatment.—The best procedure in treating rupture of a tendon is exposure by incision and the introduction of sutures. Some surgeons relax the parts and apply splints.

Thecitis, or **tenosynovitis,** is inflammation of the sheath of a tendon.

Acute thecitis may arise from a contusion, from a wound, from repeated over-action in working, from rheumatism, from gonorrhea, from influenza, from the continued fevers, or from syphilis. In early syphilis certain tendon-sheaths may rapidly develop effusion because of hyperemia of the sheaths (Taylor).

Symptoms.—In *non-suppurative* cases of thecitis the symptoms are pain, swelling, tenderness, and moist crepitus along the tendon-sheath, due to inflammatory roughening. The crepitus disappears as the swelling increases, but it reappears as the swelling diminishes. In *suppurative* cases the symptoms are great swelling, pulsatile pain, dusky dis-

[1] Walsham's case of dislocation of peroneous longus, *Brit. Med. Jour.*, Nov. 2, 1895.

coloration, inflammation spreading up the tendon-sheaths, and often the constitutional symptoms of sepsis.

Treatment.—In treating non-suppurative thecitis, employ splints and apply locally iodin, blue ointment, or ichthyol, and administer suitable remedies to combat any causative constitutional disease. In the suppurative form make free incisions, irrigate, drain, and dress with hot antiseptic fomentations.

Palmar Abscess.—A thecal abcess about the flexor tendons of the fingers travels rapidly upward and is apt to produce a palmar abscess. A thecal abscess of either the index, ring, or middle finger is usually arrested at the lower end of the palm, but suppurative thecitis of the thumb or the little finger may diffuse pus over a large surface of the palm and also up the arm (Fig. 214). Palmar abscess is a most serious affection. The pus may dissect up all the structures of the palm, may reach the dorsum, or may pass beneath the anterior annular ligament into the connective-tissue planes of the forearm.

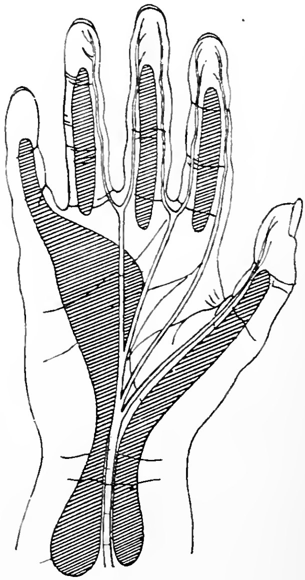


Fig. 214.—Diagram of tendon-sheaths of the hand (Tillaux).

Treatment.—A palmar abscess demands free incision and drainage at the earliest possible moment. The patient should be placed under the influence of ether. The incision is made in the line of the metacarpal bone and, if possible, below the palmar arches. A line transverse with the web of the thumb is below the palmar arches. In an incision above this line, try not to cut either arch; but if one be cut, at once take means to arrest the hemorrhage (page 336). In a severe case it may be necessary to make several palmar incisions, to open the tendon-sheaths on the flexor surface of the forearm above the wrist, and to make counteropenings in the back of the hand. In severe cases it is necessary to introduce tubes, and drain through and through. After operation apply hot antiseptic fomentations and put the part upon a splint. When granulations begin to form dry dressings are substi-

tuted for the hot moist dressing. It may be necessary to give morphin for pain, and stimulants may be needed. There is great danger of stiffness of the fingers occurring, the tendons becoming adherent to their sheaths. Hence, begin passive movements as soon as granulations begin to form.

Chronic thecitis may follow acute thecitis, but may be due to injury, to rheumatism, to gummatous infiltration, to rheumatoid arthritis, or to a tubercular inflammation of a tendon-sheath (compound ganglion). In tubercular thecitis the swelling is firm or doughy when due to granulation-tissue, but is fluctuating when due to fluid. Grating is marked. The tendon-sheath may contain numerous small bodies which are either free or are attached (rice, riziform, or melon-seed bodies). Tubercle bacilli are present in the fluid or in the granulation-tissue. Chronic thecitis is commonest in the tendons of the fingers, the ankles, and the knees; it may spread to a joint or it may arise from a tubercular joint. This condition causes very little pain. In ordinary non-tubercular thecitis the part is weak, tender, painful, and stiff, crepitates on motion, and is swollen.

Treatment.—Tubercular cases are treated as follows: in cases in which there is fluid effusion make a small incision, wash out with salt solution, introduce some iodoform emulsion, and close the wound. In cases in which there are rice-bodies, open the sheath, evacuate the contents, scrape the walls thoroughly, inject with iodoform emulsion, and close the wound. (If the annular ligament requires division, stitch it; Fig. 221.) In cases with extensive formation of embryonic tissue apply an Esmarch bandage, make a large incision, and remove all infected tissue from the sheath, around the sheath, and from the tendon. In an ordinary traumatic thecitis use for the first few days rest associated with applications of ichthyol. Later employ hot and cold douches, massage, and passive movements, strapping of the part, inunctions of ichthyol, and the hot-air bath. If effusion is persistent or rice-bodies exist, make an incision and scrape the interior of the tendon-sheath. In rheumatic cases give antirheumatic remedies and employ the hot-air bath. In syphilitic cases administer mercury and iodid of potassium.

Ganglia.—In connection with tendon-sheaths simple ganglia may develop. They are small, tense, round swellings, which are firm, grow progressively though slowly, are painless when uninflamed, and contain a fluid of the appearance and consistence of glycerin-jelly (Bowlby). Ganglia are commonest upon the dorsum of the wrist, and they

occur especially in those who constantly use the wrist-muscles. Paget states that a *simple* ganglion is due to cystic degeneration of a synovial fringe inside a tendon-sheath, and that the fluid of the ganglion does not communicate with the fluid of the tendon-sheath. Others pathologists believe a simple ganglion to be a hernia of synovial membrane through a rent in a tendon-sheath, all communication between the herniated part and the tendon-sheath being soon obliterated. *Compound* ganglion is an old name for tubercular thecitis.

Treatment.—A ganglion is treated by aseptic puncture with a tenotome, evacuation, scarification of the walls, antiseptic dressing, and pressure. An old-time method of treatment was subcutaneous rupture brought about by striking with a heavy book. Duplay treats a ganglion by injecting a few drops of iodin through a hypodermatic needle. The cyst is not evacuated before injection. The parts are dressed antiseptically, and cure is obtained in one week. Recurrent ganglia, very large ganglia, and ganglia with very thick contents should be dissected out.

Felon, or **whitlow,** is a violent rapidly spreading pyogenic inflammation of a finger or a toe which resembles cellulitis, and which is sometimes followed by gangrene or by necrosis of bone. As a rule, an injury precedes the whitlow, an abrasion of the surface which admits pus-organisms or a contusion which creates a point of least resistance. The commonest seat of a felon is the last digit of the finger or thumb. An abrasion of the surface at this point absorbs pus-organisms and the superficial lymphatics carry them directly inward, lodging them, it may be, in the skin, in the subcutaneous tissues, in the tendon-sheath, or beneath the periosteum.

Felons are very rare in infants, but may occur in children. Women are more liable to them than are men. The fingers are much more liable to infection than are the toes, because they are more exposed to injury. Several fingers may be attacked at once or successively in persons of dilapidated constitution. Whitlow is most apt to occur and is most severe in persons broken down by disease, alcoholism, overwork, or worry. In certain cases of neuritis painless suppuration may arise.

There are two forms of felons, the *superficial* and the *deep*.

If the infection is in the skin, the point of infection becomes dark red, swollen, painful, and tender. The epidermis is lifted up by the pus which forms, and a considerable area may be attacked before the spread of the process is arrested.

If the subcutaneous tissues only are involved, the symptoms are those of an ordinary cellulitis. Paronychia is a cellulitis starting at the end or side of the digit, and involving the parts around and below the nail. The pus-organisms obtain entrance by means of an abrasion, a puncture, or an ulcerated "step-mother." The pain is throbbing and violent; is increased by motion, pressure, or a dependent position; the skin is dusky red, but the swelling is slight. In about forty-eight hours pus forms in the superficial parts, the epidermis being lifted into pustules or blebs, and pus may also form under the nail. A portion of the nail, or the entire nail, may be lost.

If the tendon-sheath is involved as well as the subcutaneous tissue, the symptoms are those of suppurative cellulitis, with more marked discoloration and tenderness and more pulsatile pain.

Deep felon, or bone-felon, involves most of the structures of the finger (periosteum, bone, tendon, tendon-sheath, and cellular tissue), and may destroy the digit or the finger. It arises in the same manner as paronychia, but the organisms are lodged in the deeper parts. The pain is agonizing, entirely preventing sleep, pulsatile in character, associated with excruciating tenderness, greatly aggravated by motion or a dependent position, and often extending up the hand and forearm. The skin is dusky red and edematous, and the part is enormously swollen. Pus forms quickly; diffuse cellulitis may arise; thecal suppuration may occur; sloughing of the tendon and subcutaneous tissue may take place; necrosis of one or more bones may ensue, and in some cases gangrene of the finger follows.

In deep whitlow lymphangitis of the forearm and arm is not unusual, adenitis of the axillary glands is common, and almost always there is fever. In superficial felon constitutional symptoms are slight or absent, and lymphangitis and adenitis arise in a minority of cases. A felon may be followed by a palmar abscess, and is particularly apt to be if the disease arises in the thumb or little finger.

Treatment.—Even a superficial felon demands instant incision in all cases, and the parts must be irrigated, dressed with hot antiseptic fomentations, and the hand must be placed upon a splint. A bone-felon requires prompt incision to the bone alongside the tendon. Fig. 215 shows the proper lines of incision in the fingers and palm. Do not wait for pus to form, but allay tension and prevent pus-formation by early incision. Do not waste time with poultices: to wait means agonizing pain, sleepless nights, constitutional involvement,

and, perhaps, sloughing of tendons or death of bone. Incision and drainage constitute *the* treatment, followed by irrigation, antiseptic fomentations, and splinting of the extremity. If the patient cannot sleep, give morphin. See that the bowels are moved once a day. Give quinin, iron, and milk punch. Opening a felon is exquisitely painful; hence ether should be given in the first stage, nitrous oxid should be administered, or the superficial parts should be frozen by a spray of chlorid of ethyl.

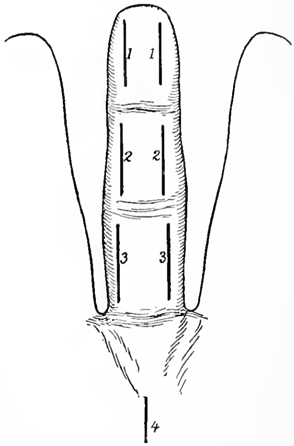


FIG. 215.—1, 2, and 3. Incisions for felon of finger and for ordinary suppuration; 4, palmar incision.

Bursitis is inflammation of a bursa. Acute bursitis arises from strain or from traumatism. The **symptoms** of acute bursitis are pain, limited swelling, moist crepitus, fluctuation, and discoloration in the anatomical position of a bursa. Bursitis of the retrocalcaneal bursa (Albert's disease) is a painful affection which is often overlooked. Walking causes great pain in the heel. Raising up on the toes is excessively painful. It is usually associated with flat foot. In these cases osteophytes often form within the bursa. There are numerous bursa about the hip. Some anatomists count twenty-one.[1] The two most important bursæ and the ones usually affected, are the iliac and the deep bursa over the great trochanter.[2] Inflammation of the iliac bursæ produces swelling below Poupart's ligament, which swelling is tense, but exhibits fluctuation on careful examination. In some cases the sac can be emptied by pressure, the fluid passing into an adjacent bursa or into the joint. The enlargement often presses on the anterior crural nerve and causes pain throughout the nerve's trajectory. The limb, according to Zuelzer, is usually slightly flexed, abducted and rotated outward, and movement in an opposite direction causes pain. Inflammation of the bursæ about the hip may produce symptoms resembling those of incipient coxalgia, but in bursitis the symptoms do not remit as in hip-disease. In inflammation of the gluteal bursæ there is moderate pain back of the thigh and knee which disappears when the patient is at rest; there is a marked limp, limitation of motion, and an

[1] Synnestvedt, of Sweden.

[2] Zuelzer, in *Zeit. f. Chir.*, vol. l.

area of deep fluctuation in the buttock (Brackett). In inflammation of the iliac bursæ flexion is not so marked as in coxalgia, and the trochanter is never above Nélaton's line. In inflammation of the deep trochanteric bursa the position is the same as in iliac bursitis, and resembles that of coxalgia. In coxalgia, however, there is pain on pressure upon the front of the joint or directly on the trochanter or on tapping the sole of the foot. These manipulations do not cause pain in bursitis (Zuelzer).

It is difficult to differentiate between inflammation of a deep bursa and synovitis; indeed, in bursitis the joint is apt to be secondarily affected. This difficulty is especially vexatious in distinguishing between joint-injury and injury of the bursa beneath the deltoid. Suppuration may take place in a bursa. Direct force may rupture a bursa. The bursa beneath the deltoid is frequently ruptured. When this accident happens there are pain, marked swelling, a large area of moist crepitus, and later extensive discoloration from blood. *Chronic* bursitis may follow acute bursitis, or the disease may be chronic from the start. Its **symptom** is swelling with little or no pain unless acute inflammation arises. Chronic bursitis of the subhyoid bursa is known as Boyer's cyst.

Treatment.—Acute bursitis is treated by rest, pressure, and the application of iodin, blue ointment, or ichthyol. If the swelling persists, aspirate and apply pressure, or incise the sac and remove it partly or completely. If pus forms, incise, paint the interior of the sac with pure carbolic acid, and pack with iodoform gauze. Chronic bursitis may be cured by the use of pressure and the application of blue ointment, and with treatment of any causative diathesis; but most cases require incision and packing. A ruptured bursa is treated as an acute bursitis. Some cases of retrocalcaneal bursitis get well from rest, but others demand incision and drainage. If osteophytic formation takes place in Albert's disease, remove the bony stalactites with a rongeur forceps or a gouge.

Housemaids' knee is thickening and enlargement of the prepatellar bursa, due to intermittent pressure (Fig. 216). In effusion into the knee-joint the fluid is behind the patella and the bone floats up; in housemaids' knee the fluid is above the bone and the osseous surface can be felt beneath it. "Miners' elbow," which is a condition similar to housemaids' knee, affects the olecranon bursa. "Weavers' bottom" is enlargement of the bursa over the tuberosity of the ischium.

A bursa which is simply thickened and enlarged rarely gives rise to annoyance; but when it inflames, as it is apt to do, it causes the ordinary symptoms of bursitis.

Treatment.—Some few cases of housemaids' knee may be cured by rest and blistering, but in most cases it is necessary to incise and pack with iodoform gauze. In enlargement

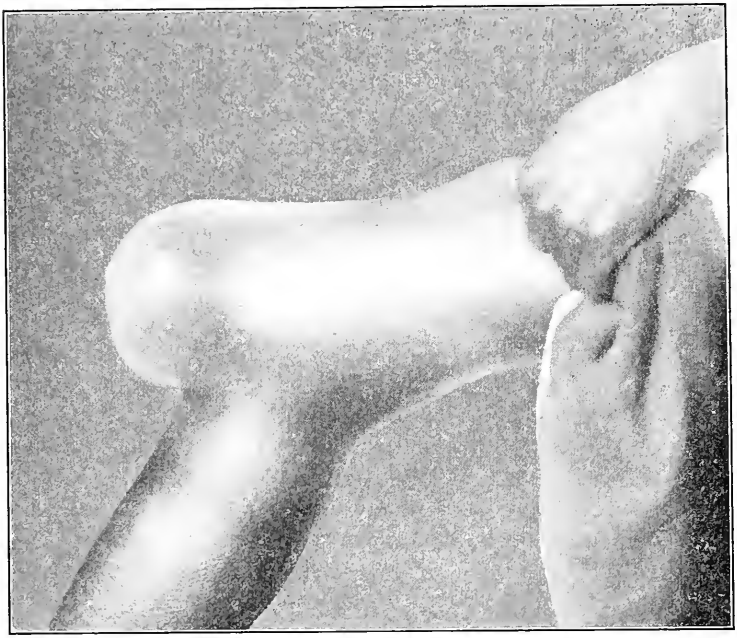


Fig. 216.—Housemaids' knee.

of the bursa beneath the ligamentum patallæ, if rest and blistering fail to cure, aspirate or incise. In enlargement of the bursa beneath the tendon of the semimembranosus and also in "weavers' bottom" incise and pack.

Bunion.—A bunion is a bursa due to pressure, and it is most commonly situated above the metatarsophalangeal articulation of the great toe, but is occasionally seen over the joint of another toe. When the big toe is pushed inward by ill-fitting boots a bunion forms. When a bunion is not inflamed it may cause but little trouble, but when it inflames the bursa enlarges and the parts become hot, tender, and excessively painful. Suppuration may occur and pus may

invade the joint, and the bone not unusually becomes diseased.

Treatment.—In treating a bunion the patient must wear shoes that are not pointed, that have the inner borders straight, and that have rounded toes (Jacobson). For a mild case a bunion-plaster gives comfort. Sayre advises the use of a linen glove over the digits, the phalanges being drawn inward by a piece of elastic webbing, one end of which is fastened to the glove and the other end to a piece of strapping from the heel. A special apparatus may be worn (Fig. 217). In many cases osteotomy of the first phalanx or of the first metatarsal bone is required; in some cases excision of the joint is necessary; in others amputation must be performed. When the bursa is not inflamed, but only thickened, blisters should be employed over it, or there should be applied tincture of iodin, ichthyol, or mercurial ointment. When the bursa inflames, ichthyol ointment is applied, and intermittent heat by foot-baths gives relief. Suppuration demands immediate incision and antiseptic dressing. If an ulcerated bunion does not heal by antiseptic dressing, stimulate it with silver and dress it with ungent. hydrarg. nitrat. (1 part to 7 of cosmolin). Jacobson recommends skin-grafting for some cases.

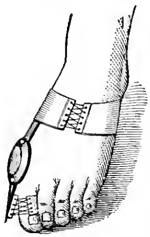


Fig. 217.—Bigg's apparatus for bunions.

Operations upon Muscles and Tendons.

Tenotomy is the cutting of a tendon. It may be *open* or *subcutaneous*, the open operation being preferred in dangerous regions.

Division of the Sternocleidomastoid Muscle for Wry-neck.—Subcutaneous tenotomy for wry-neck has been largely abandoned. It is not only more unsafe than the open operation, but it never completely divides all of the contracted band.

The instruments required consist of a scalpel, dissecting-forceps, hemostatic forceps, scissors, needles, ligatures, etc. The patient is placed recumbent, the chin being drawn more toward the opposite side.

A transverse incision is made over the muscle about one-fourth of an inch above the clavicle. The superficial parts are divided, the muscle is exposed and sectioned, bleeding is arrested, and the skin is sutured. Avoid the anterior jugular vein, which is underneath the muscle, and also the

external jugular, which is close to the outer edge of the muscle. Mikulicz advocates the removal of almost the entire muscle, leaving, however, the upper and posterior portion where the spinal accessory nerve passes. After operation for wry-neck support the head with sand bags or a plaster-of-Paris dressing until healing occurs, and then inaugurate motions active and passive.

Subcutaneous Tenotomy of the Tendo Achillis.—This operation is performed for club-foot, in which the heel is raised. The tendon is cut about one inch above its point of insertion. The instrument used for the first puncture is a sharp tenotome. The patient lies upon his back "with his body rolled a little toward the affected side" (Treves), the foot being placed upon its outer side on a sand pillow. The surgeon stands to the outer side. The tendon is rendered moderately rigid, and the sharp tenotome, with its blade turned upward, is inserted along the anterior border of the tendon until the surgeon's finger feels the knife approaching the outer side. The sharp-pointed instrument is withdrawn and a blunt-pointed tenotome is inserted in its place. The tendon is drawn into rigidity, and the surgeon turns the blade of his knife toward the tendon, places his finger over the skin, and saws toward his finger. The tendon gives way with a snap. Treves states that a beginner is apt not to push the knife far enough toward the outside, or he may in the first puncture push the knife through the tendon; in either case the tendon is not completely cut. The little wound, which is covered with a bit of gauze, will be entirely closed in forty-eight hours. In club-foot cases after tenotomy some surgeons at once correct the deformity and immobilize the limb in plaster; some partially correct the deformity and apply plaster for one week, at which time they remove the plaster, correct the deformity further, reapply the plaster, and so on; other surgeons do not attempt correction of the deformity until the cut tendon has begun to unite, when they gradually stretch the new material.

Subcutaneous Tenotomy of the Tendon of the Tibialis Anticus Muscle.—The tendon is divided about one and a half inches above its point of insertion. It can be made tense by extending and abducting the foot. The sharp-pointed tenotome is entered upon the outside of the tendon, and is passed well around it. The blunt-pointed tenotome is used to cut the tense tendon.

Subcutaneous Tenotomy of the Tendons of the Peroneus Longus and Brevis Muscles.—These two

tendons are cut together back of the external malleolus, and one and a half inches above the tip of the malleolus, so as to avoid the synovial sheath (Treves). The patient lies upon the sound side, the outer aspect of the deformed foot being upward and the inner aspect of the ankle of the deformed side resting upon a sand pillow. The instrument is introduced close to the fibula, and is carried around the loose tendons. A blunt-pointed tenotome is now introduced, its edge is turned toward the tendons, and these structures are cut as they are made tense.

Subcutaneous Tenotomy of the Tendon of the Tibialis Posticus Muscles.—This tendon is sectioned above the point where its synovial sheath begins; that is, above the internal annular ligament (Treves). The tendon is made tense and the pointed knife is entered above the base of the inner malleolus. The knife is entered just back of the inner edge of the tibia, and is carried around the muscle while it is kept close to the bone. The tendon is sectioned with a blunt knife.

Subcutaneous Fasciotomy of the Plantar Fascia.—The contracted bands are discovered by motions which render them tense, and they are divided just in front of the attachments to the os calcis. The sharp knife passes between the skin and fascia at the inner side of the sole of the foot. The fascia is cut from without inward by the blunt-pointed tenotome. It is usually necessary to section the fascia at more than one point.

Tendon-suture and Tendon-lengthening.—The instruments required in these operations are an Esmarch apparatus; curved needles, and needle-holder; chromicized gut, kangaroo-tendon, or silk for an ordinary case, silver wire for a suppurating wound. In performing tendon-suture make the part aseptic and bloodless. It is wise to apply a rubber bandage on the proximal side, the bandage being applied centrifugally, forcing the proximal end of the tendon into view (Haegler). If searching for the proximal end of a flexor of the finger, flex the injured finger, and hyperextend the adjoining fingers (Filiget). If this expedient fails, enlarge the incision, or, what is better, make a large flap in the skin. After finding the ends approximate them, being sure the proper ends are brought into contact; stitch them together with a continuous suture or with one of the sutures shown in Fig. 218, 1, 2, and 3. In a suppurating wound suture by silver wire should be tried, though it usually fails. After suturing, remove the Esmarch apparatus, arrest

bleeding, close the wound and dress it antiseptically, relax the parts, and place the limb on a splint. If, after suturing, there is much tension, stitch the cut tendon above the sutures to an adjacent tendon, and apply a splint, the finger

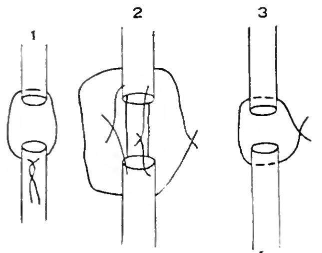


FIG. 218.—Tendon-sutures: 1, of Le Fort; 2, of Le Dentu; 3, of Lejars.

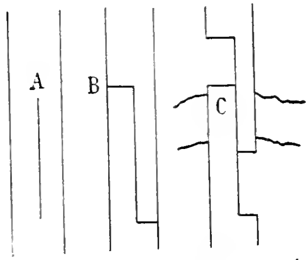


FIG. 219.—Anderson's method of tendon-lengthening.

which was injured being flexed, the others being extended. If only the distal end of the tendon can be found, graft it upon the nearest tendon with a like anatomical course and function. When a tendon has been sutured begin gentle massage in two weeks. Positive passive motion is begun in three or four weeks. In old injuries, when the ends cannot be brought into apposition, lengthen one end or both ends, either by the method of Anderson (Fig. 219) or by the method of Czerny (Fig. 220). Poncet makes

FIG. 220.—Czerny's method of tendon-lengthening.

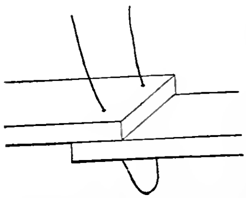


FIG. 221.—Method of suturing the annular ligament of the wrist.

several zigzag incisions on each side of the tendon, and when the tendon is pulled upon it elongates decidedly. These methods of lengthening may be used in cases of deformity from a contracted tendon. If the tendon cannot be lengthened sufficiently, make a bridge of catgut from one end of it to the other, or graft in another tendon from one of the lower animals, or graft the distal end to a tendon of like function.

The annular ligament is sutured as shown in Fig. 221.

In some cases in which a muscle has been paralyzed, Nicoladoni and others have divided the tendon of the paralyzed muscle and have united its distal end with the tendon of a normal muscle, the normal tendon being split to receive it.

XXI. ORTHOPEDIC SURGERY.

This branch of surgery formerly dealt only with the treatment of deformities by means of mechanical appliances, but of recent years its domain has been enlarged to include the treatment, surgical and mechanical, of deformities, contractures, and many joint-diseases.

Torticollis (**wry-neck**) is a condition in which contraction of certain of the neck-muscles causes an alteration in the position of the head. The disease is one-sided; the sternocleidomastoid is the muscle chiefly involved, though the trapezius, splenius, and other muscles sometimes suffer. Acute torticollis, which is rare, is a temporary condition, and results from cold or from injury (see Myalgia). Chronic torticollis may be congenital, may be due to nerve-irritation, to an assumed attitude because of eye-defect, to inflammation of the glands or to disease of the vertebræ, and it may be intermittent, but is usually persistent. The muscle stands out in bold outline, the head is turned to the opposite side, the ear of the disordered side is turned toward the shoulder, the chin is thrown forward, and spinal curvature may arise. The corresponding side of the face atrophies. There is no pain. In many cases the head may be restored to its normal position by passive movement or by voluntary effort, but it at once returns to its habitual position. Mikulicz asserts that torticollis is a chronic fibrous myositis, due often to compression during labor. He further says that the lesion known as hematoma of the sternomastoid, which occasionally follows labor, is not hematoma, but thickening due to myositis. In spasmodic wry-neck the muscle is thrown repeatedly into clonic contractions. In congenital torticollis the muscle and the cervical fascia are shortened, and the muscle does not relax under the influence of an anesthetic. In torticollis due to rheumatism and reflex causes the tonically contracted muscle relaxes when the patient is anesthetized.

Symptoms.—*Congenital* wry-neck is due to central nervous disease, to spinal deformity, or to injury during birth, and in this form the sternomastoid is shortened, hardened, and atrophied. It may not be noticed for some years because of the short neck of infancy. It is associated with a symmetrical development of the face, and is almost invariably upon the right side. *Spasmodic* wry-neck may present tonic spasm only, intermittent spasm alone, or both may appear alternately. It is a disease especially of adults; in

women it is often linked with hysteria. The exciting cause may be a cold, a blow, or a mental storm; the predisposing cause is the neurotic temperament. It may be due to enlarged glands, to carious teeth, or to eye-strain. In some rare cases bilateral spasm occurs, the head being pulled backward and the face being turned upward. Clonic spasms may come on unannounced, or they may be preceded by pain and stiffness; the head can be held still for a moment only; there is sometimes pain, always fatigue, but during sleep the contractions cease. The attack will probably pass away, but will almost certainly recur.

Treatment.—Congenital wry-neck is treated by myotenotomy (through an open wound) and the use of proper braces and supports. The old subcutaneous myotenotomy should be abandoned, as aseptic incision enables the surgeon to see and to feel all the contracted bands of fascia, muscle, and tendon, and to avoid vital structures (page 516). In spasmodic wry-neck treat the neurotic temperament and remove any obvious irritation (eye-strain, carious teeth, enlarged glands). In persistent cases stretch or divide and exsect a part of the spinal accessory nerve. To reach this nerve, make an incision along the posterior edge of the sternocleidomastoid muscle, find the nerve as it emerges from under the middle of the muscle, and retract the muscle at this point (Keen). For the treatment of rheumatic wry-neck see Myalgia (page 614).

Dupuytren's contraction is a contraction of the palmar fascia, of its digital prolongations, and of the fibers joining the fascia and skin. Fixed contraction of one or more fingers occurs. The ring-finger and the little finger most often suffer. The condition may be symmetrical. The disease arises oftenest in men beyond middle age. The **cause** of this disease is unknown: some refer it to gout or rheumatism; others to traumatism, reflex irritation, or neuritis.

Symptoms.—Dupuytren's contraction is indicated by a small hard lump or crease which appears over the palmar surface of the metacarpophalangeal joint. This nodule grows and the corresponding finger is pulled down. In some cases the tip of the finger is forced against the palm. The skin becomes dimpled or puckered.

Treatment.—In treating Dupuytren's contraction subcutaneous multiple incisions may be made, the tense fascia and the fasciocutaneous fibers being cut. The finger is straightened and is placed upon a straight splint, which is worn continuously for a week or ten days and is worn at night for

at least a month. A more satisfactory operation is that of Keen. Keen divides the skin by a V-shaped cut, the base of the V being downward, lifts up the flap, and dissects out the contracted tissue.

Syndactylism (webbed fingers) is always congenital, and may persist through several generations. Simple incision of the web is useless; the operation to be performed is that of Agnew or of Diday (Figs. 222, 223).

In Agnew's operation a flap of skin from the dorsum is inserted between the fingers and sutured in place.

In Diday's operation a flap is taken from the dorsal surface and another flap is raised from the palmar surface, and each flap is sutured to the finger from which it springs.

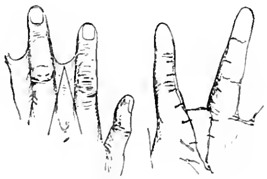


FIG. 222.—Agnew's operation for webbed fingers (Pye).

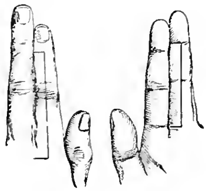


FIG. 223.—Diday's operation for webbed fingers (Pye).

Polydactylism (supernumerary digits) is always congenital, is often hereditary, and is usually symmetrical. There may be an incomplete digit, or there may be an entire and well-developed finger or toe with a metacarpal or metatarsal bone. The connection to the metacarpus or metatarsus may be by a fibrous pedicle only. If the digit is complete, with a metacarpal bone, no operation is required; if it is incomplete or is ill-developed, it should be removed.

Trigger-finger or Jerk-finger.—The patient can close the fingers, but on trying to open them one finger remains closed. It can be opened by grasping it with the other hand, but flies open with a snap like an opening knife (Abbe). The condition is due to enlargement of the flexor tendon, or to contraction of the groove in the transverse ligament in the palm (Tubby). This condition may be due to a ganglion, enchondroma, or tenosynovitis.

Treatment.—If a trauma, a ganglion, or inflammation exists, treat by ordinary means. If there is no obvious cause, put a compress over the tunnel in the ligament and apply a splint.

Mallet-finger.—This is called also drop-finger and rupture of the extensor tendon. It is due to a blow in the direction of flexion when the finger is extended. It is supposed to

be due partly to stretching and partly to rupture of the extensor tendon at the point at which it is the posterior ligament of the distal interphalangeal joint. Abbe has shown that baseball-players are liable to a condition which is the reverse of this, in which the last phalanx is dislocated backward. Drop-finger is treated by incision and suture of the tendon to the periosteum (Abbe).

Genu valgum (**knock-knee**) results from an unnatural growth of the internal condyle, causing the shaft of the femur to curve inward and the internal lateral ligament of the knee-joint to stretch, the knees coming close together and the feet being widely separated. This deformity is usually noted when the child begins to walk, but it may not appear until puberty or even long after. Knock-knee may arise from rickets, from an occupation demanding prolonged standing, or from flat-foot. It may occur in one knee or in both knees.

Treatment.—Mild rachitic cases of knock-knee may remain in slight deformity, or may get well from improvement of the general health. In ordinary cases simply treat the rickety condition. The patient is forbidden to stand or to walk, and the limb, after being put as straight as can be, is fixed on an external splint and a pad is put over the inner condyle. Later in the case plaster of Paris is used. Some surgeons prefer to immobilize while the leg is flexed to a right angle with the thigh. In a severe case the surgeon can immobilize after forcibly straightening (causing an epiphyseal separation) or after the performance of osteotomy (Fig. 193). Osteotomy is preferable to fracture by a mechanical appliance (osteoclasis).

Genu varum (**bow-legs**) is the opposite of knock-knee. Usually both legs are bowed *out*, the knees being widely separated, the tibiæ and femurs, as a rule, being curved, and the feet being turned in. This disease in early life is due to rickets, the weight of the body producing the deformity. In older people incurable bow-legs may arise from arthritis deformans.

Fig. 224.—Talipes equinus (Albert).

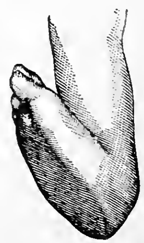


Fig. 225.—Talipes calcaneus (Albert).

Treatment. — Some mild cases of genu varum recover as a result of improvement in the health. Ordinary cases

are treated by braces, by plaster-of-Paris bandages, and by attention to the general health. When the bones have hardened osteotomy is necessary.

Club-hand.—A congenital deformity in which the hand deviates from the normal relation to the forearm. It is usually associated with other deformities. In some cases the radius and possibly some of the carpal bones are absent.

Treatment.—By massage and passive motion, by immobilization, by tenotomy or osteotomy.

Talipes (club-foot) is a permanent deviation of the foot. There are several forms. *Talipes equinus* (Fig. 224) is a confirmed extension; *talipes calcaneus* (Fig. 225) is a confirmed flexion; *talipes varus* is a confirmed adduction and inversion; and *talipes valgus* is a confirmed abduction and eversion. Two of these forms may be combined, as in talipes equino-varus (Fig. 226), talipes equino-valgus, talipes calcaneo-varus, and talipes calcaneo-valgus. The **causes** of talipes are congenital or acquired. The congenital form is due to persistence of the fetal form of the foot. Acquired cases may arise from infantile paralysis, from spastic contractions, from cicatrices, from traumatisms, from arrest of bony growth following upon the inflammation of bone, or from hysterical contractures.

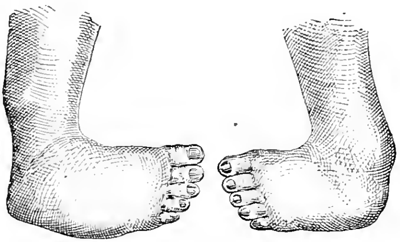


FIG. 226.—Double equino-varus (*Am. Text-book of Surgery*).

Talipes equinus is rarely congenital. In this condition the patient walks upon the toes and cannot bring the heel to the ground.

Talipes Calcaneus.—The patient walks upon the heel and cannot bring the toes to the ground. The true form is seen in congenital cases, the flexors of the foot being shortened, and the tendo Achillis being lengthened.

Talipes varus is rarely met with without equinus. In this condition the patient walks on the outer edge of the foot.

Talipes valgus is met with in flat-foot. The patient walks on the inner edge of the foot.

Talipes equino-varus.—The heel is raised and the patient walks upon the outer edge of the foot. This is the usual congenital form.

Talipes equino-valgus is very rarely congenital. The heel

is raised and the patient walks upon the inner side of the foot.

Talipes calcaneo-varus is a combination of calcaneus and varus.

Talipes calcaneo-valgus is a combination of calcaneus and valgus.

Treatment.—In congenital cases the condition is usually manifest on both sides, and is nearly always talipes equino-varus. Congenital club-foot should be treated in infancy, and when a restoration to position can be effected by the hands of the surgeon, is treated by plaster-of-Paris bandages. If a child has begun to walk, it may still be possible to correct the deformity eventually by manipulations, by plaster-of-Paris bandages, or by club-foot shoes, but most cases require tenotomy of the tendo Achillis before the application of the shoe or the plaster. The club-foot shoe may do good service, but in many instances it is painful and is not so efficient as plaster of Paris. In severe cases, before applying the plaster, the patient is given ether; the surgeon cuts the tendo Achillis, the tendons of the anterior and posterior tibial muscles, and the plantar fascia, and forcibly corrects the deformity. In old cases with alteration in the shape of the bones, cuneiform osteotomy, or the removal of the cuboid or other tarsal bones, may be indicated. In these cases Phelps advises an open transverse division of all rigid plantar soft parts. Buchanan employs subcutaneous division of all resistant structures. In some cases of talipes calcaneus the surgeon may be forced to shorten the tendo Achillis. In talipes due to infantile paralysis the operative treatment is the same, but we should not immobilize in plaster, but rather in some apparatus which can easily be removed to permit the use of massage and electricity. In paralytic cases Nicoladoni's operation is occasionally employed. This consists in dividing the tendon of the paralyzed muscle and attaching its distal end to the adjacent tendon of a healthy muscle. (For full consideration, see a work on Orthopedic Surgery.)

Pes planus (flat-foot) is a condition in which there is loss of the arch of the foot due to muscular paralysis or ligamentous weakness, to prolonged standing, or to trauma. Flat-foot is especially apt to occur in rickets. Spurious flat-foot, or inflammatory flat-foot, occurs in Pott's fracture, and in inflammation of the ankle-joint or the tendon of the peroneus longus. Paralytic flat-foot is seen after infantile paralysis. Static flat-foot is due to "lack of balance between the

weight of the body and the length of the foot" (Moore). All children are born with pronated feet, but the arch usually begins to form soon after birth; in some cases it never forms. Pes planus is productive of much pain upon standing or walking; in fact, the individual may be completely crippled. Pain is quickly relieved upon sitting down. Walking upon the toes is not painful. Flat-foot can at once be recognized by wetting the sole of the patient's foot with a colored fluid and causing him to step firmly upon a piece of paper (Fig. 227, A, B). It can also be detected by measurement to find the middle of the foot. In flat-foot the extremity is lengthened. Golding-Bird points out that the middle of the foot is the point of articulation of the inner cuneiform and the metatarsal bone of the great toe. In flat-foot the greatest change is in the posterior half of this line. The extent to which the posterior measurement exceeds the anterior is the degree of flat-foot. The excess may reach three-fourths of an inch.

Fig. 227.—Print of a normal foot-sole (A) and of a flat foot-sole (B) (Albert).

Treatment.—In static flat-foot rest in bed is employed for two weeks, and then exercise is practised several hours a day to increase the arch. Rising upon the toes again and again is valuable. After exercise the patient rests for a time, sitting tailor-fashion with legs crossed under him. Massage is valuable. A shoe should be made containing a piece of steel so arranged as to raise the arch of the foot. The patient's general health must also be attended to. In very severe cases, with fixation and bone formation, operation may be required. Gleich shortens the foot and raises the arch by sawing through the os calcis and fastening the posterior part of this bone at a lower level. Trendelenburg advises supramalleolar osteotomy. This operation permits of adduction, and the adducted foot should be put up in an immovable dressing of plaster of Paris. Ogston resects the astragaloscaphoid joint; Golding-Bird and Davy remove the scaphoid bone; Stokes removes a wedge-shaped piece from the head and neck of the astragalus. In paralytic flat-foot, which arises from infantile paralysis, employ exercise, electricity, and massage.

Pes cavus (hollow-foot) is an increase in the arch of the foot, due to contraction of the peroneus longus muscle

or to paralysis of the muscles of the calf. It is the opposite of flat-foot.

Treatment.—A shoe is worn containing a plate of steel in the sole, and pressure is applied over the instep. Tenotomy, division of the plantar fascia, or excision of bone may be required. In paralytic cases apply electricity and massage to the paralyzed muscles.

Hallux valgus, or **varus,** a displacement of the great toe outward or inward, may occur in the young, but it is most frequent in old men. It arises often from wearing narrow shoes, but may be due to gout or to rheumatic gout. In hallux valgus a bunion is apt to form over the metatarso-phalangeal joint.

Treatment.—An arrangement may be worn to straighten the toe and to protect the bunion (Fig. 217), osteotomy may be performed upon the metatarsal bone, the joint may be excised, or amputation may be required.

Hammer-toe (Fig. 228) is a condition in which there is flexion of one or more toes at the first interphalangeal joint. Shattuck shows that this condition is due to contraction of "the plantar fibers of the lateral ligaments of the joint."[1] This disease usually begins in youth. A bunion is apt to form, and the joint may become dislocated.

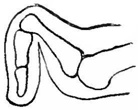


FIG. 228.—Hammer-toe.

Treatment.—Terrier's plan of treatment consists in making a dorsal flap, removing a bursa if one is found, dividing the extensor tendon, opening the articulation, removing each articular surface with cutting-forceps, suturing the soft parts, and applying a plantar splint for two weeks.[2] Some surgeons excise the joint. Probably amputation of the toe is the best treatment.

Metatarsalgia (Morton's Disease).—This disease was first described by Dr. Thomas G. Morton of Philadelphia, in 1876. It is a painful condition of the foot, due to jamming of a nerve between the heads of the fourth and fifth metatarsal bones. The head of the fifth metatarsal bone is, by lateral pressure, forced against and below the neck of the fourth metatarsal, and as a result the superficial branch of the external plantar nerve and its two digital branches are squeezed. It is usually associated with flat-foot. Pain is produced by walking, and the suffering may be so severe that the patient is obliged to sit down at once. When the shoe is removed and the foot is rested the pain soon abates. The pain is felt on the outer and inner sides of the little toe, the

[1] *American Text-book of Surgery.* [2] *Revue de Chirurgie*, July, 1895.

outer side of the fourth toe, and about the head of the fifth and the neck of the fourth metatarsal bones. Pain can be developed by grasping the foot in the hand and squeezing it. If flat-foot exists, there is also pain due to this trouble.

Treatment.—Mild cases may be cured occasionally by wearing well-fitting shoes and employing massage. Some cases require a brace. Severe cases demand resection of the fourth metatarsophalangeal joint, or amputation of the fourth toe, and with it the head of the fourth metatarsal bone. Graham of Washington has cured cases by excising a portion of the superficial branch of the external plantar nerve.

Coxa vara is a disease characterized by bending of the neck of the femur, the hip-joint being perfectly healthy, and the condition, as a rule, being unilateral. This condition was described by Müller in 1889. Coxa vara begins, as a rule, between the thirteenth and twentieth years, and the commonly accepted view has been that the deformity is rachitic, but Kredel has reported two congenital cases.[1] The patient develops a limp, and grows tired after slight exertion, but there is no swelling nor tenderness, and little or no pain. Shortening after a time becomes apparent, and the trochanter can be detected above Nélaton's line. The extremity is adducted. The *x*-rays show the deformed bone.

Treatment.—As long as bending is progressing employ rest. When the bone hardens perform osteotomy below the trochanters.

Flail-joints.—After an attack of infantile paralysis involving the entire lower extremity of each side, the limbs become limp and swing flail-like when the extremity is made to move, and the joints are much relaxed. In such cases the psoas and iliacus muscles are never completely paralyzed, and the aim of the surgeon is to utilize these muscles in enabling the patient to walk. In many cases the application of apparatus is sufficient. In others ankylosis may be established in the ankles and knees by operation. If ankylosis is established in these joints, the psoas and iliacus muscles become able to move the legs.

[1] *Centralbl. f. Chir.*, Oct. 17, 1896.

XXII. DISEASES AND INJURIES OF NERVES.

1. Diseases of Nerves.

Neuritis, or **inflammation of a nerve,** may be limited or be widely distributed (multiple neuritis). The first-mentioned form will here be considered. The causes of neuritis are traumatism, wounds, over-action of muscles, gout, rheumatism, syphilis, fevers, and alcoholism.

Symptoms.—The symptoms of neuritis are as follows: excessive pain, usually intermittent, in the area of nerve-distribution. The pain is worse at night, is aggravated by motion and pressure, and occasionally diffuses to adjacent nerve-areas or awakens sympathetic pains in the opposite side of the body. The nerve is very tender. The area of nerve-distribution feels numb and is often swollen. Early in the case the skin is hyperesthetic; later it may become anesthetic. The muscles atrophy and present the reactions of degeneration; that is, the muscles first cease to respond to a *rapidly*-interrupted, and next to a *slowly*-interrupted, faradic current; faradic excitability diminishes, but galvanic excitability increases. When, in neuritis, faradism produces no contraction, a slowly-interrupted galvanic current which is so weak that it would produce no movement in the healthy muscle causes marked response in the degenerated muscle. In health the most vigorous contraction is obtained by closing with the — pole; in degenerated muscles the most vigorous contraction is obtained by closing with the + pole. When voluntary power returns galvanic excitability declines, but power is often nearly restored before faradic excitability becomes manifest (Buzzard).

Treatment.—The treatment of neuritis consists of rest upon splints, and the use of an ice-bag early in the case and a hot-water bag later. Blisters over the course of the nerve are of value, especially in traumatic neuritis. Massage and electricity must be used to antagonize degeneration. A descending galvanic current allays pain to some extent. Deep injections of chloroform may allay pain. Treat the patient's general health, especially any constitutional disease or causative diathesis. The salicylate of ammonium or phenacetin may be given internally. In some cases nerve-stretching is advisable.

Neuralgia is manifested by violent paroxysmal pain in the trajectory of a nerve. This disease, unless it is excessively severe and persistent, is treated, as a rule, by the physician. Neuralgia of stumps and scars is a surgical condition,

and is due to neuromata, or entanglement of nerve-filaments in a cicatrix. Tic douloureux and other intractable neuralgias require careful removal of any cause of reflex irritation (stomach, eyes, uterus, nose, throat, etc.). Tic douloureux has been treated by removal of the Gasserian ganglion; removal of Meckel's ganglion; ligation of the common carotid artery; neurectomy of terminal branches of the fifth nerve; division of motor nerves; massive doses of strychnin (Dana) and purgatives (Esmarch).

Treatment of Neuralgia of Stumps.—Excise the scar; find the bulbous end of the nerve and cut it off. Senn tells us to section the nerve by V-shaped cuts, the apex of the V being toward the body, and to suture the flaps together. Senn's method will prevent recurrence. In some cases re-amputation is performed. In entanglement of a nerve in a scar remove a portion of a nerve above the scar.

2. Wounds and Injuries of Nerves.

Section of Nerves (as from an incised wound).—After nerve-section the entire peripheral portion of the nerve degenerates and ceases structurally to be a nerve in a few weeks, but after many months, or even years, the nerve may regenerate—with difficulty, if union of the ends has not taken place, with much greater ease if the ends have united. The proximal end degenerates only in the portion immediately adjacent to the section; it rapidly regenerates, and a bulb or enlargement composed of fibrous tissue and small nerve-fibers forms just above the line of section; this bulb adheres to the perineural tissues. Union of a divided nerve is brought about by the projection of an axis-cylinder from the proximal end or from each end and the fusion of these cylinders. The nearer the two ends are to each other the better the chance of union.

Symptoms.—Pronounced changes occur in the trajectory of a divided nerve. The muscles degenerate, atrophy and shorten, and develop the reactions of degeneration. When union of the nerve occurs the muscles are restored to a normal condition. If the nerve contains sensory fibers, complete anesthesia (to touch, pain, and temperature) usually follows its division; but if a part is supplied by another nerve as well as by the divided one, anesthesia will not be complete. Trophic changes arise in the paralyzed parts. Among these changes are muscular atrophy; glossy skin; cutaneous eruptions; ulcers; dry gangrene; painless felons; falling of the

hair; brittleness, furrowing or casting off of the nails; joint-inflammations; and ankylosis. Immediately after nerve-section vasomotor paralysis comes on, and for a few days the paralyzed part presents a temperature higher than normal. The diagnosis as to which nerve is cut depends upon a study of the distribution of paralysis and anesthesia.[1]

Treatment.—In all recent cases of nerve-section, suture the ends of the divided nerve. In 123 cases of primary suture, 119 were cured in from one day to one year (Willard). In 130 cases of secondary suture, 80 per cent. were more or less improved (Willard). The return of sensation may be rapid or may be slow; muscular power returns more slowly than sensation. If the patient is not seen until long after the accident, incise and apply sutures (secondary sutures); if the nerve cannot be found, extend the incision, find the trunk above and trace it down, and find the trunk below and follow it up. Even after primary suture loss of function is bound to occur for a time. After secondary suture sensation may return in a few days, but it may not return until after a much longer period; in any case muscular function is not restored for months. After partial section of a nerve the ends should be sutured. In performing secondary suture it may be necessary to effect "lengthening" in order to approximate the ends. Transplantation of a portion of nerve is sometimes practised. Transplantation is bridging the gap by means of a portion of nerve from one of the lower animals or from a recently amputated human limb. Nerve transplantation may fail utterly, it may be followed by great improvement; but absolute and perfect restoration of function cannot be obtained. R. Peterson[2] has made a study of the 20 recorded cases of nerve transplantation. Eight of the operations were primary, and 12 were secondary. The periods after the injury at which operation was performed varied from forty-eight hours to a year and a quarter. Four of the 8 primary cases improved. Eight of the 12 cases of secondary operation showed improvement in motion or sensation. The distance between the nerves did not seem to affect the results. No case recovered completely, but in one case sensation returned completely and only the abductors of the thumb remained weak. In most cases benefited sensation returned by the tenth day and motion in two and a half months. In one of the suc-

[1] See Bowlby on *Injuries of Nerves.*
[2] *Am. Jour. Med. Sciences*, April, 1899.

cessful cases, that of Mayo Robson,[1] the spinal cord of a rabbit was used.

Pressure upon nerves may arise from callus, scars, a dislocated bone, a tumor, or pressure from an external body.

The **symptoms** may be anesthetic, paralytic, or trophic.

The **treatment** is as follows: remove the cause (reduce a dislocated bone, chisel away callus, excise a scar, etc.); then employ massage, douches, exercise, and electricity.

Dislocation of the Ulnar Nerve at the Elbow.—This condition is very rare. It may occur as a complication of a fracture or a dislocation, or as an uncomplicated condition. It may be produced by violence or by muscular effort, which ruptures the fascia the function of which is to retain the nerve back of the inner condyle of the humerus. In some cases the symptoms are slight and transitory, the nerve functionating well in its new situation. As a rule, there are pain, numbness, or anesthesia of the ulnar trajectory, some stiffness of the elbow, and stiffness of the little finger and ring finger. The nerve can be felt in front of the inner condyle of the humerus. In some cases neuritis follows, with trophic changes.

Treatment.—*McCormick's Operation.*—Expose the nerve by an incision, incise the fibrous tissue back of the inner condyle, and press the nerve into the bed prepared for it and hold it in place by sutures of kangaroo-tendon passing through the triceps tendon. Wharton advises suturing also "the margin of the fascial expansion of the triceps tendon superficial to the nerve.[2]

Contusion of Nerves.—The **symptoms** of contusion of nerves may be identical with those of section. Sensation or motion, or both, may be lost. The case may recover in a short time, or the nerve may degenerate as after section.

The **treatment** at first is rest, and later electricity, massage, frictions, and douches.

Punctured Wounds of Nerves.—The **symptoms** of punctured wounds of nerves may be partly irritative (hyperesthesia, acute pain, and muscular spasm) and partly paralytic (anesthesia, muscular wasting, and paralysis).

The **treatment** after the puncture has healed is the same as that for contusion.

[1] *Am. Jour. Med. Sciences*, April, 1899.

[2] A report of fourteen cases of dislocation of the ulnar nerve at the elbow, by H. R. Wharton, *Am. Jour. Med. Sciences*, Oct., 1895.

3. Operations upon Nerves.

Neurorrhaphy, or Nerve-suture.—When a nerve is completely or partially divided by accident it should be sutured. The instruments required are an Esmarch apparatus, a scalpel, blunt hooks, dissecting-forceps, hemostatic forceps, curved needles or sewing-needles, a needle-holder, and catgut, silk, or kangaroo-tendon. In primary suture render the part bloodless and aseptic. Enlarge the incision if necessary. If the ends can readily be approximated, pass two or three sutures through both the nerve and its sheath and tie them (Fig. 229). If the ends cannot be approximated, stretch each end and then suture. Remove the Esmarch band, arrest bleeding, suture the wound, dress antiseptically, and put the part in a relaxed position on a splint. After union of the wound remove the splint and use massage, frictions, electricity, and the douche. The operation in some instances fails, but in many cases succeeds. In some few cases sensation returns in a few days, but in most cases does not return for many weeks or months. Sensation is restored before motor power. *Secondary suture* is performed upon cases long after division of a nerve. The part is rendered aseptic and bloodless; an incision is made; the bulbous proximal end is easily found and loosened from its adhesions; the shrunken distal end is sought for and loosened (it may be necessary to expose the nerve below the wound and trace its trunk upward); the entire bulb of the proximal end is cut off; about one-quarter of an inch of the distal end is removed (Keen); each end is stretched, and the ends are approximated and sutured together. If stretching does not permit of approximation, adopt one of Bowlby's expedients (Fig. 230), or graft a bit of nerve from a recently amputated limb or from a lower animal (it makes no difference as to whether the grafted nerve were motor, sensory, or mixed). Mayo Robson has succeeded in grafting the spinal cord of a rabbit in the median nerve of a man. The restoration of function was almost complete. Allis suggested shortening the limb by excising a piece of bone, and the operation has been carried out successfully by Keen, Rose, and others. Letiévant

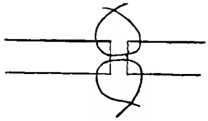


Fig. 229.—Nerve-suture.

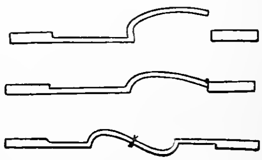


Fig. 230.—Suture of a nerve by splitting the ends (Beach).

attaches the cut end of the peripheral portion of a divided nerve to an adjacent uncut nerve. Assaky uses the suture *à distance*, composed of catgut passing from end to end and serving as a bridge for reparative material.

Neurectasy, Neurotomy, and Neurectomy.—*Neurectasy*, or nerve-stretching, may be applied to motor, sensory, or mixed nerves. A nerve can be stretched about one-twentieth of its length (Vogt). Neurectasy has been employed for neuralgia, neuritis, muscular spasm, hyperesthesia, anesthesia, painful ulcer, perforating ulcer, and the pains of locomotor ataxia. The operation, which was once the fashion, seems to benefit some cases, but it is not now thought so highly of as formerly. The incision for neurectasy is identical with the incision for neurectomy or neurotomy of the same nerve. *Neurotomy*, or section of a nerve, is only performed upon small and purely sensory nerves. It is performed chiefly for peripheral neuralgia or for some other painful malady. It is useless, because sensation soon returns. Paget saw complete return of sensation in four weeks after division of the median nerve. Corning endeavors to prevent this regeneration by inserting oil between the ends. He uses oil of theobroma containing enough paraffin to make the melting-point 105°F. The oil is melted, is injected around the nerve, and cold is applied. The nerve is now sectioned with a canaliculated knife, the ends are separated widely, more oil is injected, and cold is again applied. The theory is that this oil, which is solid at the temperature of the body, devitalizes the nerve at the point of section and acts as a barrier to the passage of regenerating fibers. This method has been applied especially in cervicobrachial neuralgia.[1] *Neurectomy*, or excision of a portion of a nerve-trunk, is only applicable to sensory nerves and to painful affections.

Stretching of the Sciatic Nerve.—Some surgeons stretch the sciatic nerve by anesthetizing the patient and holding the leg and thigh in line, strong flexion being made upon the hip, the entire lower extremity being used as a lever (Keen). This method, which has caused death, inflicts needless damage, and the operative plan is safer and better. The instruments required are a scalpel, hemostatic forceps, dissecting-forceps, a dissector, retractors, and a scale with a handle and a hook. The patient lies prone, the thighs and legs being extended. An incision four inches in length is made a little external to the middle of the thigh, and going at once through the deep fascia; the biceps muscle is

[1] *Med. Rec.*, Dec. 5, 1896.

found and is drawn outward; the nerve is discovered between the retracted biceps on the outside and the semitendinosus on the inside, resting upon the adductor magnus muscle. The nerve, which is caught up by the finger, is first pulled down from the spine and then up from the periphery, and finally the hook of the scale is inserted beneath the trunk and the nerve is stretched to the extent of forty pounds. Very rarely is even a single ligature needed. The wound is sutured and dressed. If the incision is made at a higher level below the gluteofemoral crease, the sciatic nerve will be found just by the outer border of the biceps.

Neurectomy of the Infraorbital Nerve.—The instruments required in this operation are a scalpel, dissecting-forceps, aneurysm-needle, hemostatic forceps, blunt hooks, a dissector, and metal retractors. The patient lies upon his back, the head being a little raised by pillows. The surgeon stands to the outside of and faces the patient. A curved incision one and a half inches long is made below the lower border of the orbit. The nerve lies in a line dropped from the supraorbital notch to between the two lower bicuspid teeth. The nerve is found upon the levator labii superioris muscle, and a piece of silk is passed under the nerve by an aneurysm-needle and firmly fastened. The upper border of the incision is drawn upward; the periosteum of the floor of the orbit is elevated and held by a retractor; the roof of the infraorbital canal is broken through; the nerve is picked up far back with the blunt hook and is divided with scissors, and the entire nerve is drawn out by making traction upon the silk. The bleeding in the orbit is checked by pressure. The wound is stitched without drainage.

Neurectomy of the Supraorbital Nerve.—In this operation shave off the eyebrow. The instruments required and the position of the patient are as for the operation upon the infraorbital nerve. A curved incision one inch long discloses the nerve as it emerges from the supraorbital notch or foramen at the junction of the inner and middle thirds of the eyebrow. The nerve is pulled forward and cut off above and below.

Neurectomy of the Inferior Dental Nerve.—The instruments are the same as for any other neurectomy, and in addition a chisel, a mallet, and a rongeur forceps. Make a curved incision around the angle of the jaw. Lift the supramaxillary branch of the facial nerve downward (Kocher). Separate the masseter muscle with a periosteum-elevator and slight touches with the knife. Chisel an opening in the center

of the ascending ramus (Velpeau's rule). This opening exposes the beginning of the dental canal (Kocher). If necessary, the opening may be enlarged with a rongeur. Pull the nerve out with a hook and remove a piece from it.

Removal of the Gasserian Ganglion.—This operation is dangerous, bloody, and difficult, and is only undertaken in very severe cases of tic douloureux, and in cases upon which less grave procedures have failed. The operation usually cures the pain if the patient recovers from the actual procedure. The mortality is from 12 to 15 per cent. In some cases the pain has subsequently returned. Out of Keen's 9 cases of removal, 3 had corneal trouble, but in not one case was the eye lost. Some atrophy is apt to be noted in the tongue, and the eye becomes insensitive and watery.

Operation.—The surgeon is provided with the instruments for osteoplastic resection of the skull. Krause and others employ a surgical engine. Special retractors, various hooks, scalpels, a dry dissector, dissecting- and hemostatic forceps, and an electric forehead-light are required. Long strips of gauze must be ready for packing in case of hemorrhage.

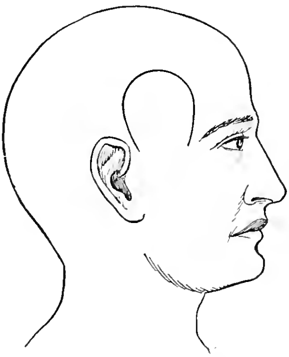


FIG. 231.—Hartley's osteoplastic flap in removal of Gasserian ganglion (Tiffany).

The patient is placed recumbent, with head turned to the opposite side. A large osteoplastic flap is formed in front of the ear (Fig. 231), and is broken down. Hemorrhage is arrested. It may be found that the meningeal artery has been ruptured. If this accident has happened, and the vessel lies in a bony canal, plug with Horsley's wax. If the vessel is bleeding upon the dura, ligate by passing suture-ligatures around it. If it is torn off at the foramen spinosum,

pack with iodoform gauze, and postpone the rest of the operation for forty-eight hours. It may be necessary at any stage of this formidable operation to pack the wound and postpone completion for two days. The next step is to lift up the dura and with it the brain (Fig. 232). Find the inferior

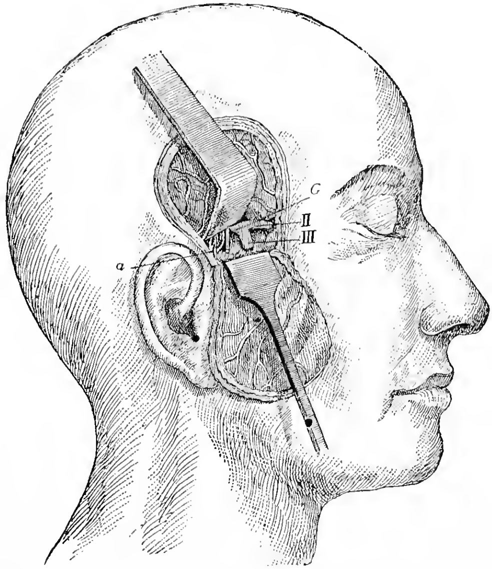


FIG. 232.—Removal of Gasserian ganglion: A, middle meningeal artery; II, ophthalmic division; III, submaxillary division; G, ganglion (Krause).

maxillary nerve and clamp it with hemostatic forceps. Find the superior maxillary nerve and clamp it. Loosen the nerves from their beds with a dry dissector. Twist the clamp-forceps so as to reel up the nerves. This pulls out the ganglion intact with the motor root and the root of origin, as far back as the pons (Krause's method). Arrest bleeding; close the flap; sew the lids of the affected side together; and cover the eye with a watch-crystal.

XXIII. DISEASES AND INJURIES OF THE HEAD.

1. Diseases of the Head.

In approaching cases of brain disorder, first endeavor to locate the seat of the trouble; next, ascertain the nature of the lesion; and, finally, determine the best plan of treatment, operative or otherwise. In all operations upon the

brain the surgeon must be able to determine accurately the situations of certain fissures and convolutions, the finding of the situations of these convolutions and fissures comprising the science of craniocerebral topography.

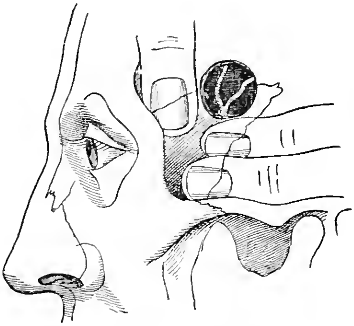


FIG. 233.—The meningeal artery exposed by trephining (after Esmarch).

The regional terms used in craniocerebral topography are derived from Broca (Fig. 234). The middle meningeal artery is found at the pterion, one and one-quarter inches posterior

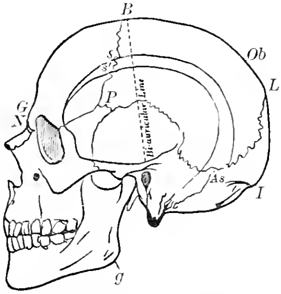


FIG. 234.—Skull showing the points named by Broca: *As*, asterion (junction of the occipital, parietal, and temporal bones); basion, middle of anterior wall of foramen magnum; *B*, bregma (junction of the sagittal and coronal sutures); *G*, ophryon (on a level with the superior border of the eyebrows, and corresponding nearly to the glabella, the smooth swelling between the eyebrows); *g*, gonion (angle of the lower jaw); *I*, inion (external occipital protuberance); *L*, lambda (junction of sagittal and lambdoidal sutures); *N*, nasion (junction of the nasal and frontal); *Ob*, obelion (the sagittal suture between the parietal foramina); *P*, pterion (point of junction of great wing of sphenoid and the frontal, parietal, and squamous bones. This may be H-shaped or K-shaped, or "retourné," in which the frontal and temporal just touch); *S*, stephanion (or, better, the superior stephanion, intersection of ridge for temporal fascia and coronal suture); *S'*, inferior stephanion (intersection of ridge for temporal muscle and coronal suture).

to the external angular process, on a level with the roof of the orbit (Fig. 233). The fissures and convolutions of the brain are shown in Figs. 235–237. The *fissure of Bichat* is marked by a line on each side drawn from the inion to

the external auditory process. A line from the glabella to the inion overlies the median fissure and the superior longitudinal sinus. The *fissure of Rolando* is very important, as marking the motor region of the brain. It begins in the median line, half an inch posterior to the middle of the distance between the inion and glabella (Keen). This fissure runs downward and forward at an angle of 67.5° for a distance of three and three-eighths inches. Chiene finds the fissure of Rolando by the following method: he takes a square piece of paper and folds it into a triangle (Fig. 239, 1); the angle B A C of this triangle is 45°; the edge D A is folded back on the dotted line A E; the angle D A E equals half of 45°, or 22.5°, and the angle C A E equals the same (Fig. 239, 2); unfold the paper in the line C A; in the figure thus formed B A C=45° and E A C=22.5°; E A B=67.5°, which is the angle desired. Place the

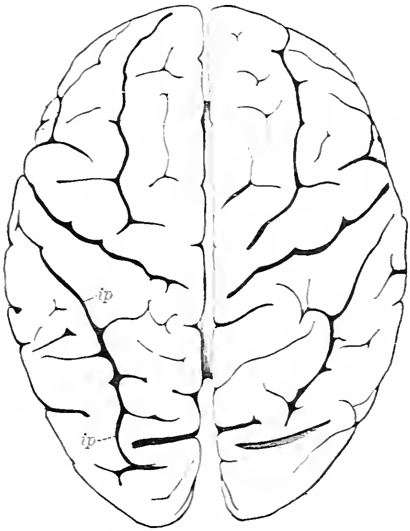


FIG. 235.—View of the brain from above (Ecker).

point A in the mid-line of the head, over the point of origin of the Rolandic fissure; the side A B is laid along the middle line of the head, and the line A E corresponds to the fissure of Rolando.[1] Fig. 238 shows Chiene's scheme for locating various points upon the brain. Horsley determines the situation of the Rolandic fissure by the use

[1] *American Text-book of Surgery.*

of his metal cyrtometer (Fig. 240). He places the point marked zero over the inioglabellar line and midway between the inion and the glabella. To find the *fissure of*

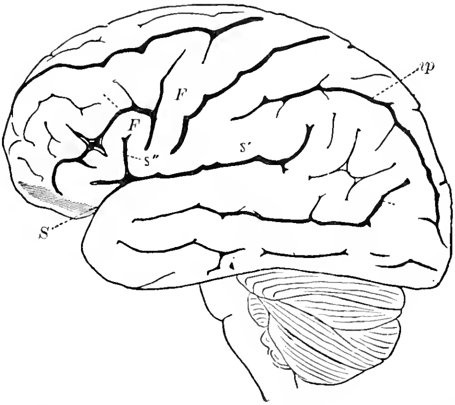


FIG. 236.—Outer surface of the left hemisphere of the brain (Ecker).

Sylvius (Fig. 236, *S*, *s'*, *s''*), draw a line from the external angular process to the occipital protuberance. The fissure of Sylvius begins on this line one and one-eighth

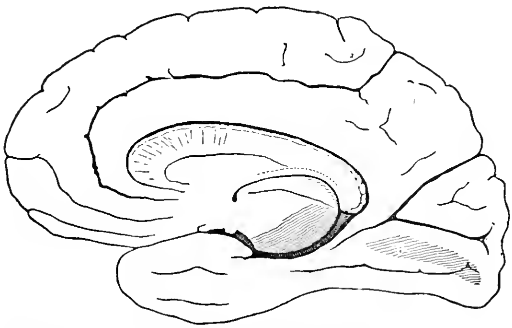


FIG. 237.—Inner surface of the right hemisphere of the brain (Ecker).

inches behind the external angular process; the main branch of the fissure runs toward the parietal eminence; the ascending branch of the fissure corresponds to the squamoso-sohenoidal suture, and continues upward in the

same line half an inch above the suture. The *precentral sulcus* (Fig. 236, F) limits anteriorly the ascending frontal convolution; it runs parallel with and just behind the

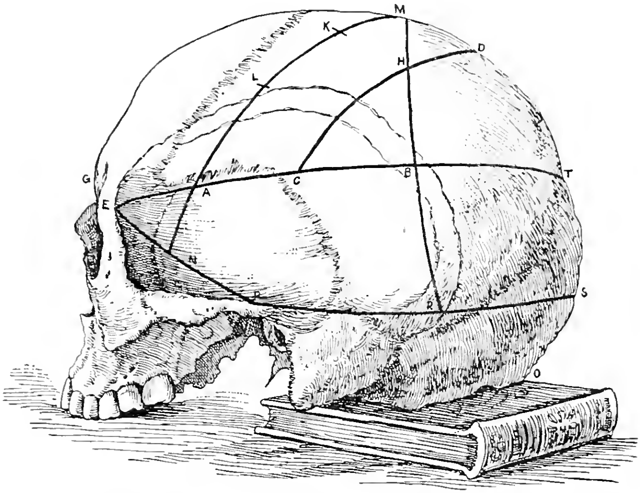


Fig. 238.—Chiene's lines for localizing brain-areas: M D C A, Rolandic or motor area; A, anterior branch of middle meningeal and bifurcation of fissure of Sylvius; A C, horizontal part of Sylvian fissure; the highest part of the lateral sinus touches P S at R; M A, precentral sulcus; I, beginning of inferior frontal sulcus; K, beginning of superior frontal sulcus; M B C contains the supramarginal convolution; B, angular gyrus.

coronal suture, and a finger's breadth in front of the fissure of Rolando. The *intraparietal fissure* (Figs. 235, 236, *ip*) limits the motor region posteriorly. It begins opposite the junction of the lower and middle thirds of the fissure of

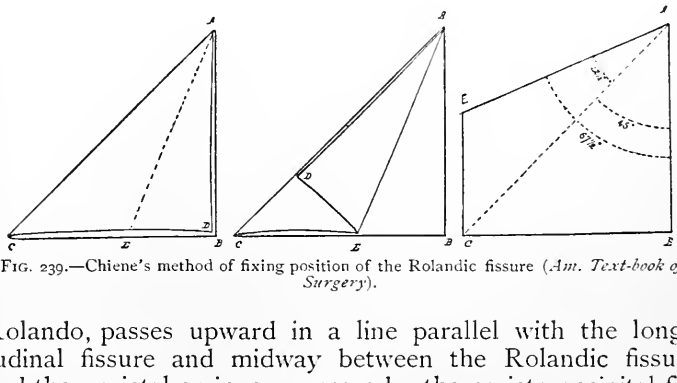


Fig. 239.—Chiene's method of fixing position of the Rolandic fissure (*Am. Text-book of Surgery*).

Rolando, passes upward in a line parallel with the longitudinal fissure and midway between the Rolandic fissure and the parietal eminence, passes by the parieto-occipital fis-

sure, and downward and backward into the occipital lobe. The motor areas, which on the outer surface are adjacent to the fissure of Rolando, are shown in Figs. 235 and 236.

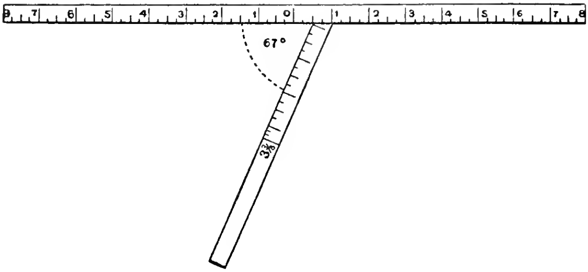


FIG. 240.—Horsley's cyrtometer.

The superior longitudinal sinus is overlaid by a line from the inion to the glabella. The lateral sinus is indicated by a line running from the occipital protuberance horizontally outward to a point one inch posteriorly to the external auditory meatus, and from this point by a second line dropped to the mastoid process. The suprameatal triangle of Macewen is bounded by the posterior root of the zygoma, the posterior bony wall of the auditory meatus, and a line joining the two. The mastoid process is opened through Macewen's triangle to avoid injury to the lateral sinus. Barker's point, the proper spot to apply the trephine in abscess of the temporosphenoidal lobe, is one and one-fourth inches above and one and one-fourth inches behind the middle of the external auditory meatus. Fig. 241 shows clearly the main points of craniocerebral topography, obtained by methods approved by many scientists.

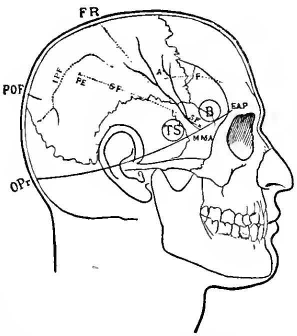


FIG. 241.—Head, skull, and cerebral fissures: B corresponds to Broca's convolution; EAP, external angular process; FR, fissure of Rolando; IF, inferior frontal sulcus; IPF, intraparietal sulcus; MMA, middle meningeal artery; OPr, occipital protuberance; PE, parietal eminence; POF, parieto-occipital fissure; SF, Sylvian fissure; A, its ascending limb; TS, tip of temporosphenoidal lobe. The pterion (to the left of B) is the region where three sutures meet, viz., those bounding the great wing of the sphenoid where it joins the frontal, parietal, and temporal bones (adapted from Marshall by Hare).

Diseases of the Scalp.—The scalp is composed of skin, subcutaneous fat, and the occipitofrontalis muscle and aponeurosis. The scalp is liable to inflammation from various

causes, and also to other diseases—namely, tumors, cysts, warts, moles (local cutaneous hypertrophies), cirsoid aneurysm (page 324), nevi, and lupus. *Abscesses of the scalp* are common. If an abscess forms beneath the pericranium, the pus diffuses over the area of one bone, being limited by the attachment of the pericranium in the sutures. If an abscess forms in the tissue between the occipitofrontalis and the pericranium, it is widely diffused. Treves calls this subaponeurotic connective tissue "the dangerous area." Abscess of the subcutaneous tissue is apt to be limited because of the great amount of fibrous tissue. Abscess is treated by instant incision at the most dependent part, antiseptic irrigation, and drainage.

Diseases and Malformations of the Bones of the Skull.—The bones of the skull are liable to caries, necrosis, osteitis, periostitis, atrophy, hypertrophy, tumors, etc. (see Diseases of Bones).

Microcephalus.—By microcephalus is meant unnatural smallness of the head due to imperfect development. Marked microcephalus is not a common condition, but it is an occasional cause or associate of idiocy. A child may be born with a skull completely ossified even at the fontanelles, or the ossification may become complete soon after birth, but in many cases of microcephalus ossification takes place late or not at all. In microcephalus the face is apt to be fairly well developed; the jaws are prominent; the forehead is flat; the cranium and brain are small; the convolutions of the brain are simpler than is natural; there is apt to be marked asymmetry of the two sides of the brain; internal hydrocephalus may exist; areas of sclerosis and atrophy are common; porencephaly is not unusual. Some patients have perfect motor power; others are slow and inco-ordinate. Epilepsy, chorea, and athetosis frequently complicate the case. Idiots of this type often present deformities such as cleft-palate, strabismus, distorted ears, hypertrophied tongue, deformed genitals or extremities, ill-shaped and irregularly developed teeth. They exhibit irregular muscular movements, are frequently paralyzed in childhood (infantile paraplegia or hemiplegia), and suffer from subsequent contractures. These idiots are active, destructive, excitable, and are liable to be violent and almost demoniacal. Clouston says they look impish and unearthly.

Treatment.—Skilled training in a school for the feeble-minded or in an institution for idiots is necessary in treating microcephalus. Idiots have but little power of attention,

and sensory impressions give rise to but few concepts, and these are feeble and fleeting. In order to educate the idiot it is highly desirable that speech be acquired, and "the more strongly the attention can be aroused the more perfect does speech become" (Kirchhoff). The principle of the education of idiots is to stimulate, co-ordinate, and guide sight, hearing, and feeling.

Lannelongue of Paris has suggested an operation in cases of idiocy with premature ossification (see Linear Craniotomy, page 692). In this procedure the author has no confidence. Idiocy is a general disorder and not a local brain disease. Soft parts mould bone, and bone does not mould soft parts. There is no evidence that the brain is being compressed; in fact, the simplicity of the convolutions suggests the contrary. In many typical cases of microcephalic idiocy there is no synostosis even years after birth. The operation has been much abused. It is sometimes fatal, and, although a fatality may gratify the family, a surgeon is not a legal executioner. The remarkable improvement which has been reported in some cases results probably from misconception; the new surroundings, the strange faces, the firm discipline, the effect of the anesthetic, and the shock of the operation attract the feeble attention and rouse the sluggish senses. Many cases are brought for operation because they are for the time being unusually intractable and excitable, and the return to the usual level of conduct after operation is regarded as a permanent gain when it is often but a temporary alleviation. We believe that scientific training is the proper treatment, and that the efficiency of training is not increased by the previous performance of craniotomy, and we follow the precept of Agnew, that a surgeon might as well cut a piece out of a turtle's back to make a turtle grow as to cut a piece out of the skull to make the brain grow.

Diseases and Malformations Involving the Brain.—**Meningocele** is a congenital protrusion of the cerebral membranes through a bony aperture, the sac containing some extracerebral fluid. Meningocele feels and looks like a cyst (is translucent and fluctuates); it does not usually pulsate, it has a small base, it becomes tense on forcible expiration, and it may be reduced.

Encephalocele is a congenital protrusion not only of membranes, but also of a portion of the brain as well, the sac containing some extracerebral fluid. Encephalocele is small, opaque, does not fluctuate, has a broad base, does

pulsate, becomes tense on forced expiration, and attempts at reduction cause pressure-symptoms.

Hydrencephalocele is a congenital protrusion of membranes and brain-substance, the interior of the mass communicating with the ventricles and containing ventricular fluid. This is the most frequent and the most dangerous form. Hydrencephalocele is larger than a meningocele, is translucent, fluctuates, rarely pulsates, is pedunculated, is rendered a little tense on forced expiration, and cannot be reduced.[1]

Treatment.—For hydrencephalocele nothing can be done, and early death is inevitable. In rare instances an encephalocele is converted into a meningocele, and the bony aperture closes, thus bringing about a cure. Among the expedients for treating meningocele and encephalocele are electrolysis, injection of Morton's fluid (gr. x of iodin, gr. xxx of iodid of potassium, ℥j of glycerin), pressure and excision. In cases of meningocele, when portions of the nerve-centers are not contained in the sac, Mayo Robson advises the performance of a plastic operation. He ligates the neck of the sac, cuts away the sac, sutures the skin-flaps separately, and leaves the stump outside the line of superficial sutures. It is usually possible to tell by palpation if nerve-centers are in the sac, but if in doubt, make an exploratory incision, and sweep the finger around inside of the sac.[2]

Hydrocephalus.—In *external* hydrocephalus the fluid is between the membranes and the brain; in *internal* hydrocephalus the fluid is in the ventricles. Hydrocephalus may be *acute* or *chronic*, *congenital* or *acquired*.

Acute hydrocephalus, which results from meningitis (particularly tubercular meningitis), is usually internal, but may be external. The symptoms are headache, elevated temperature, delirium, stupor, convulsions, paralysis, and choked disk.

Treatment of acute hydrocephalus is of no avail. Tapping of the ventricles may be tried.

Chronic hydrocephalus is usually congenital. The cranium enlarges enormously and the bones of the skull are widely separated. The broad forehead overhangs the eyes. The child is an idiot, and very often does not learn to walk or to talk. Convulsions and palsies are common, and blindness is frequent. Such children usually die young.

The *treatment* of chronic hydrocephalus is rarely of much

1 *American Text-book of Surgery.*

2 *Am. Jour. Med. Sciences*, Sept., 1895.

avail. Pressure by strapping with adhesive plaster has been tried. Tappings through a fontanelle may be performed by means of a trocar (only ℥ij or ℥iij of fluid being drawn at a time). If much fluid is drawn, the head must be strapped afterward. If the skull ossifies, the lateral ventricles may be tapped. It has been proposed to drain by tapping the theca of the spinal cord (Quincke). This last operation is called lumbar puncture (page 713).

2. Injuries of the Head.

Caput succedaneum is a collection of bloody serum under the scalp of a new-born child and results from the pressure of labor. The pressure was about but not at the point where the bloody serum gathered. No treatment is required.

Scalp-wounds are treated as are other wounds. Even a large piece of scalp with only a narrow pedicle may not slough; hence try to save any piece that has an attachment. Always shave a wide area and disinfect the wound thoroughly. Stitch the wound with silkworm-gut. The hemorrhage can, in most instances, be controlled by the sutures which are used to close the wound. If drainage is required, use a few strands of silkworm-gut.

Contusions of the Head.—Scalp-swelling from hemorrhage is usually considerable. The patient may be stunned or dazed. The swelling of hematoma must not be mistaken for *fracture* with depression. In hematoma there is a central depression, hard pressure on the centre finds bone on a level with the general contour of the bone, and the margin of a hematoma is circular, is not quite hard, and is elevated above the general contour. In depressed fracture the edge is on a level with or below the level of the general bony contour, and the margin is sharp and irregular. The **treatment** is by means of pressure and the use of lead-water and laudanum. If suppuration arises, at once incise.

Concussion or Laceration of the Brain.—For many years it has been customary to regard concussion as a condition produced by molecular vibrations in the nervous substance of the brain. Duret's classical observations have profoundly modified surgical thought, and have led to the opinion that in concussion of the brain there is injury to the brain itself, a rupture of cerebral vessels brought about by the advance and recession of a wave of cerebrospinal fluid. This wave first flows in the direction of the force. Keen says that there may be slight brain-injuries which can

properly be called "concussions," but it is better to consider concussion as synonymous with laceration of the brain. It seems, however, highly improbable that slight cases of concussion are accompanied by vascular rupture or organic mischief, the symptoms are too transitory, and reaction too rapid and complete to permit of any such view. These slight cases are identical with and at least can not be distinguished from shock. The cause of concussion is violent force, either direct (as a blow upon the head) or indirect (as a fall upon the buttocks). This force shakes, oscillates, or jars the brain, giving rise to waves of cerebrospinal fluid, which sometimes rupture vascular twigs, large vessels, or even the membranes. In the slighter ruptures concussion only exists; in the severe ruptures compression soon arises.

Symptoms.—In a slight case of brain-concussion the patient may or may not fall; his face is pale; he feels weak, giddy, nauseated, and confused; he often vomits, but soon reacts. In a severe case he lies with complete muscular relaxation, cold extremities, pale and cold skin, shallow and quiet respiration, frequent, small, soft, and irregular pulse (pulse may not be detectable), and fluttering heart. He seems unconscious, but can usually be roused to monosyllabic response by shouting, pinching, or holding a bright light near his face. Occasionally, however, there is complete unconsciousness. The urine and feces are often passed involuntarily. The pupils may be unaltered, may be dilated or contracted, or may be equal or unequal, but in any case they will react to light. Paralysis rarely exists, but if there is paralysis it is temporary. The temperature at first is subnormal. In a severe cortical laceration there will be twitchings or even general convulsions, or the patient will lie curled up with limbs flexed and eyelids shut, and will resist all attempts to open his eyes or mouth or to move his limbs (A. Pearce Gould). Erichsen called this condition "cerebral irritability." As the patient reacts he will most probably vomit. Within twenty-four hours he usually improves, but is feverish and complains of headache and lassitude, sometimes becomes delirious, and in rare cases develops mania. After concussion recovery may be complete, but, on the contrary, a person's whole nature may change: he may develop hysteria, insanity, or epilepsy, and in many cases there is complaint for a long time of headache, insomnia, low spirits, and lassitude. If the patient in concussion recedes from, instead of advancing toward, recovery, coma will set in or inflammation will develop. Keen states that

the prognosis is always uncertain. Any concussion producing unconsciousness is a serious injury, because considerable laceration has probably occurred.

Treatment.—In treating brain-concussion, bring about reaction by the administration of aromatic spirits of ammonia (no alcohol, as this agent excites the brain), by pouring a few drops of ammonia on a handkerchief and holding it near the nose, by surrounding the patient (who lies in bed with a pillow) with hot bottles, by hot irrigation of the head, by the application of mustard over the heart, and by the administration of hot coffee or hot saline enemata. Do not pour fluid into the patient's mouth until he becomes able to swallow. If he cannot swallow, rely on hot enemata and hypodermatic injections of strychnin. Place the patient in bed in a quiet room, and watch him. If reaction is inordinate, apply cold to the head, give arterial sedatives and diuretics, and purge. For some days or for some weeks, according to the case, insist on an easy life. Give a plain diet containing a minimum of meat, administer an occasional purgative, and secure sleep. Sleep can often be obtained by some simple expedient, such as the administration of warm milk, placing a hot-water bag to the abdomen or feet, or applying a mustard plaster for a short time to the back of the neck. In cases where obstinate wakefulness exists, it becomes necessary to give bromid, chloral, sulphonal, trional, or some other hypnotic. Morphin is avoided because it is thought to increase venous congestion of the brain, but the elder Gross often used it, especially in cerebral irritation. If signs of compression arise, it is best to trephine, as the compressing agent may be a clot (see page 663). If inflammation arises, some surgeons will not trephine; but it is wise and proper, especially if the damage seems to be localized, to incise the scalp and inspect the bone. If a fracture is discovered and the symptoms are serious, perform an exploratory trephining, open the dura, and secure drainage for inflammatory products.

In any severe contusion the surgeon should at once incise the scalp and inspect the bone. For many weeks after a grave concussion a patient must be kept away from business and be watched because of the possibility of an abscess of the brain arising, and because of the liability of such patients to develop hysteria, neurasthenia, or insanity.

Compression of the Brain.—The causes of brain-compression are hemorrhage, depressed fracture, tumor, in-

flammatory exudate, pus, and foreign bodies. Death tends to happen from respiratory failure, not from heart-failure (Horsley).

Symptoms.—In great or sudden brain-compression complete coma exists without voluntary movement. The skin is hot and perspiring; the respirations are slow and stertorous, and the cheeks flap during expiration; the pulse is slow and full, and may be irregular; the pupils are somewhat dilated, and do not respond readily to light. In a unilateral compression the pupil on the side of the compressing-cause is apt to be much dilated if the compression is affecting the base of the brain. In cerebral compression there are usually retention of urine, and often incontinence of feces; paralysis exists, which may be very limited (monoplegia), may be of one side (hemiplegia), or may be general. In hemorrhage into the interior of the brain the unconsciousness is immediate or nearly so. In bleeding from the middle meningeal artery a period of consciousness intervenes between the injury and the coma, in which period blood collects and the coma comes on gradually. In compression from depressed fracture or from a foreign body the symptoms usually come on at once, but they may be deferred for some hours. Compression from inflammation or pus begins gradually after a considerable time has elapsed.

A **diagnosis** must be made between coma due to brain-injury and the comatose conditions of apoplexy, uremia, epilepsy, hysteria, diabetes, opium-poisoning, and alcoholic intoxication. In hospital practice cases of unconsciousness without a known history are frequent. In attempting this diagnosis examine carefully for any evidence of traumatism, and inquire as to how and where the patient was found, if any fit occurred, and if a bottle or a pill-box was found near by or in the pockets. The surgeon should himself examine the pockets. Smell the breath to notice alcohol or opium, but always remember that a man may be stricken with apoplexy while he is drunk, and may fracture his skull by falling when under the influence of opium or of alcohol. Draw the urine with the catheter if any water is in the bladder; examine the urine for albumin and alcohol, and take the specific gravity. In doubtful cases of coma use the ophthalmoscope. In *post-epileptic coma* the temperature is never below normal, there are no unilateral symptoms, the condition resembles sleep, and the patient can be aroused. *Hysterical coma* occurs in boys and women; there are no objective symptoms, and the patient, though swallowing what is

put into his mouth, cannot be roused (Gowers). In *uremia*, besides the condition of the urine (and always remember that a person with albuminuria is apt to develop apoplexy), there is a persistent subnormal temperature, and convulsions are prone to occur. There is edema of the legs, and paralysis and stertor are absent. In *apoplexy* hemiplegia exists, and the initial temperature is for a short time subnormal. A single convulsion may have ushered in the case. *Alcoholic unconsciousness* is often diagnosticated when apoplexy really exists. A man will smell of alcohol who has had one drink, but one drink will not produce coma; hence the smell of alcohol is not conclusive. In any case of doubt some hours of watching will clear up the diagnosis. Regard a doubtful case as serious until the truth is clear. In *opium-poisoning* the pupils are contracted to a pin-point, the respirations are usually slow, shallow, and quiet, but may be stertorous, but there is no paralysis. Always remember that hemorrhage into the pons will produce pin-point pupils, but it also causes paralysis (crossed paralysis if in the lower half of the pons) and high temperature with sweating. In opium-poisoning the temperature is subnormal. In *diabetic coma* the pupils will react to a very bright light, the temperature is subnormal, and the breath and the urine smell like chloroform.

Treatment.—The treatment of brain-compression depends on the cause. Hemorrhage (extradural or subdural) requires trephining and arrest of bleeding; coma from depressed fracture demands trephining and elevation; foreign bodies must be removed; abscesses must be evacuated; some tumors are to be removed. In cerebral compression, if death is threatened by respiratory failure, make artificial respiration, and at once trephine over the supposed region of compression (Victor Horsley). Horsley has shown that irrigation of the head with hot water is of great value in bringing about reaction from shock in cases of brain-injury.

Intracranial hemorrhage may be either *spontaneous* or *traumatic*. In the vast majority of instances spontaneous hemorrhage comes from the lenticulo-striate artery (Charcot's artery of cerebral hemorrhage), and produces apoplexy, a disease belonging to the physician except in some ingravescent cases, for which ligation of the common carotid on the same side as the rupture is indicated. Traumatism during delivery is a not unusual cause of hemorrhage from the middle meningeal artery (Richardiére). A traumatic hemorrhage may take place (1) between the bone and the dura (*extra-*

dural); (2) between the dura and the brain (*subdural*); and (3) in the brain-substance (*cerebral*).

(1) **Extradural hemorrhage** arises from the middle meningeal or, more often, from one of its branches. A spicule of bone may penetrate a venous sinus and produce extradural hemorrhage, or a sinus may rupture. Rupture of the meningeal artery or one of its branches is usually, but not always, accompanied by fracture; in fact, in some cases not even a bruise can be found. The ruptured vessel may be upon the opposite side, hence the evidence of scalp-injury is not a certain sign of the side of the skull involved. The accident may or may not cause temporary unconsciousness; but even if it does, from this unconsciousness the patient almost always reacts, and there is a *distinct period of consciousness* between the accident and the lasting coma, the coma being due to pressure from a continually increasing mass of extravasated blood. If the main trunk or a large branch is ruptured, the period of consciousness is short; if a small branch is ruptured, the period of consciousness is prolonged for hours or perhaps for days. As the clot forms and enlarges the patient becomes heavy, dull, stupid, and sleepy, he sleeps so soundly he can scarcely be aroused and snores loudly, and finally passes into stupor and then into coma. The other signs of this condition are paralysis of the side opposite the blood-clot (not necessarily of the side opposite the injury, for the artery may rupture from contre-coup on the uninjured side); this paralysis is apt at first to be localized, but it gradually and progressively widens its domain. If the clot extends toward the base, the pupil on the same side as the clot ceases to react to light, becomes immobile and dilates widely, and, if the clot be on the left side, aphasia is noted. As the clot enlarges adjacent centers become involved. The face becomes paralyzed, then the arm, and finally the leg. Not unusually epileptiform attacks occur, starting in discharges from the centers which are irritated by the advancing clot before their function is abolished by pressure. The pulse becomes full, strong, usually slow, but occasionally frequent; the breathing becomes stertorous; the temperature rises, that of the paralyzed side exceeding that of the sound side. In a compound fracture the pressure of escaping blood may force brain-matter out of the wound (Keen). In extradural hemorrhage from a sinus the symptoms cannot be differentiated from those produced by arterial rupture.

Treatment.—In treating extradural hemorrhage localize

the clot, not by the seat of the wound or contusion, but entirely by the symptoms. To reach the middle meningeal artery or its anterior branch, trephine one and one-fourth inches back of the external angular process, at the level of the upper border of the orbit (Krönlein) (Fig. 233). If this incision does not expose the clot, trephine again at the level of the upper border of the orbit and just below the parietal eminence. The first incision gives access to the trunk and to the anterior branch; the second incision exposes the posterior branch. If signs indicate that the clot is travelling to the base, the trephine should be used half an inch lower than the point first indicated. Arrest bleeding by a suture ligature or by packing (page 340), and always open the dura and inspect the brain. By this procedure a subdural hemorrhage may be discovered which, without it, would have been missed. Drainage must be employed.

(2) **Subdural hemorrhage** is usually due to depressed fracture and rupture of the middle cerebral artery or of a number of small vessels. The *symptoms* are identical with those of extradural bleeding, but are usually very rapid in onset.

The *treatment* is trephining at the first point, enlarging the opening upward and backward with a rongeur, opening the dura, turning out the clot, ligating the bleeding point or packing, elevating any depression of bone, draining, and stitching the dura with catgut. Hemorrhage from internal pachymeningitis requires the same treatment.

(3) **Cerebral Hemorrhage.**—The *symptoms* of cerebral hemorrhage are identical with those of apoplexy. The *treatment* is the same as that for apoplexy, except in ingravescent cases, when the common carotid on the same side as the clot may be ligated.

Rupture of a sinus usually arises from compound fracture or during a brain-operation. The **treatment,** if the rupture happens from fracture, is trephining. Enlarge the opening by the rongeur, pack with *one large piece* of iodoform gauze, or catch the rent with hemostatic forceps, leaving them in place for three or four days, or apply a lateral ligature or a suture ligature. Elevate depressed bone. In rupture during an operation control hemorrhage by packing.

Fractures of the skull may be *simple, compound, depressed, non-depressed,* or *punctured.* They are divided into fractures of the *vault,* usually due to direct force, and fractures of the *base,* due to extension of fractures of the vault, to indirect violence (a fall upon the feet, the buttocks, or the

vault), to forcing of the condyles of the lower jaw against or through the base, or to foreign bodies breaking through the orbit, vault of the pharynx, the ear, or the roof of the nostrils. Fracture by contre-coup, which occurs on the side opposite the application of the violence, is very rare. Fractures of the skull are uncommon in early youth, but they are much more frequent in the aged. Usually the entire thickness of the bone is fractured, but either the outer or the inner table may be broken alone. In complete fractures the inner table is broken more extensively than is the outer table, because the inner table is the more brittle, because the force diffuses, and also, as Agnew taught, because the inner table is part of a smaller curve than is the outer table, and violence forces bone-elements together at the outer table, but tears them asunder at the inner table (Figs. 242, 243).

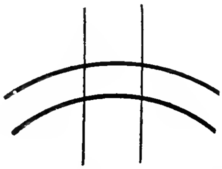


Fig. 242.—Section of outer and inner tables, with two parallel lines (after Agnew).

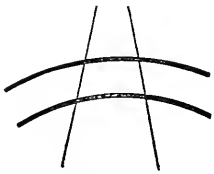


Fig. 243.—Greater yielding of the inner table than of the outer after the application of violence (after Agnew).

Fractures of the Vault.—A fracture of the vault of the skull may be simple and undepressed, or it may be depressed, compound, or comminuted. A mere crack may exist in a bone, and if a rent exists in the soft parts, a bit of dirt or a hair may be caught in the crack. Fractures of the vault arise from direct force. A fissure may escape recognition, although in some cases percussion gives a "cracked-pot" sound. Any considerable depression can be detected. In a simple fracture occasionally the cerebrospinal fluid collects under the scalp and forms a tumor which pulsates and becomes tense on forcible expiration (puffy tumor of Pott). Compound fractures can be readily recognized, but do not mistake a suture, a Wormian bone, or a tear in the pericranium for a fracture. A fissured fracture is marked by a dark line of blood which *sponging will not remove.* Fracture of the inner table alone can only be suspected (Keen). The prognosis of fractures of the vault depends upon the extent of brain-injury rather than upon the extent of bone-injury. Simple fractures unite by bone; compound fractures with loss of bone unite only by fibrous tissue. The dangers may

be *immediate* (hemorrhage, brain-injury, and septic inflammation) or be *distant* (epilepsy, insanity, and persistent headache).

Treatment.—A simple fracture without depression and without brain-symptoms is treated expectantly (by rest, quiet, low diet, purgation, moderate elevation of and cold to the head, and arterial sedatives). A simple fracture with moderate depression and without cerebral symptoms is treated expectantly, and so also is a simple fracture in which symptoms existed but are abating. Simple fracture with marked depression requires immediate trephining, even when brain-symptoms are absent. Some surgeons make an exception in young children, and wait awhile before trephining, in the expectation that the expansile brain will lift the depressed but elastic bone up to the level. Trephining in cases where no symptoms exist, although there is marked depression, often prevents disastrous consequences arising in the future, and is known as "preventive trephining" (Agnew, Keen, Horsley, Macewen, v. Bergmann, and others). In all compound fractures, shave and asepticize the entire scalp, enlarge the incision, and explore the bone. If a fissure exists it must be asepticized, and if a hair or other foreign body is found in it, in order to effect removal and secure asepsis the outer table of the skull must be cut away with a chisel, the fissure being thus converted into a broad groove. In a compound fracture with much depression, trephine, elevate, and irrigate. In any fracture, trephine if distinct symptoms exist. In punctured wounds of the brain (punctured fractures), *always* trephine, open the dura, and disinfect (Keen). In any case of fracture of the vault where trephining has been performed, it is wise to open the dura and examine the brain.

Fractures of the Base.—A fracture of the base of the skull may exist in only one of the three fossæ, in two of them, or it may involve all. The middle fossa is oftenest involved. Fracture of the posterior fossa is the most fatal. These fractures may be due to direct violence, to indirect force, and to extension of a fracture of the vault. Extension from the vault is always by the shortest route. Fracture by direct violence may arise from the penetration of the nasal roof, the orbital roof, or the pharyngeal roof by a foreign body. The posterior fossa may suffer from a fracture by direct violence applied to the neck. Fractures by indirect force may arise from blows upon the frontal bone (the orbital portion of the frontal or the cribriform process of the ethmoid breaking), from falls upon the chin (the condyle of the

jaw breaking the middle fossa), or from falls upon the buttocks, the knees, or the feet (fracture occurring in the posterior fossa). The base is very rarely broken by contre-coup (Treves).

Symptoms.—Fractures of the base of the skull are apt to be compound. A solution of continuity in the pharynx, roof of the nares, orbit, or ear, permits access of air to the seat of fracture and allows blood and cerebrospinal fluid to flow externally. In fracture of the anterior fossa the fracture may be compound, because of laceration of the mucous membrane of the nares or of the conjunctiva. Blood may run from the nose, its source being the vessels of the mucous membrane or the dura, the fracture being compound. Epistaxis does not prove the fracture to be compound, but only suggests it; but if the epistaxis is prolonged, the probability is greatly increased; and if the flow of blood is succeeded by a flow of cerebrospinal fluid the diagnosis of compound fracture is positive. Cerebrospinal fluid only appears when the mucous membrane, the dura, and the arachnoid are each lacerated (Treves). In fractures of the anterior fossa blood is apt to flow into the orbit, producing subconjunctival ecchymosis, and some blood is often swallowed and vomited. In fractures of the middle fossa blood may flow from the ear through a tear in the tympanum, its source being the vessels of the tympanum, the meningeal vessels, or a sinus. Blood may flow through the Eustachian tube and come from the nose, may be spit up, or may be swallowed and vomited. In many cases a quantity of cerebrospinal fluid flows from the ear, the discharge being increased by expiratory effort and a position which favors gravity. The cerebrospinal fluid must not be confused with either blood-serum or liquor Cotunnii. The cerebrospinal fluid is always present in large amount; the liquor Cotunnii can only be present in minute amount. Blood-serum is highly albuminous; cerebrospinal fluid is a serous fluid of very low specific gravity, never shows more than a trace of albumin, and contains considerable chlorid of sodium and in some instances sugar, which, when present, reacts to Trommer's and to Moore's tests, but does not reflect polarized light nor ferment with yeast (Keetley, from Collins). Treves states [1] that cerebrospinal fluid cannot flow from the ear in fractures of the middle fossa unless (1) the line of fracture crosses the internal meatus, (2) unless the prolongation of the membranes into the meatus is torn, (3) unless a communication exists between the internal ear and tympa-

[1] *Applied Anatomy.*

num, and (4) unless the drum-membrane is torn. Miles of Edinburgh[1] claims that bleeding from the ear followed by a flow of cerebrospinal fluid is not pathognomonic of fracture of the middle fossa of the base. He maintains that when the drum is ruptured we may have these signs, when bone is not broken, the chief source of the blood being the vessels of the pia and temporosphenoidal lobe, the blood and cerebrospinal fluid flowing inside the sheath of the auditory nerve, passing into the vestibule, through the lamina cribrosa, and from the vestibule into the middle ear, finding exits from this space by way of the Eustachian tube, and also through the rent in the drum-membrane. Profuse serous discharge may flow from the ear after an injury without fracture when the drum is ruptured, the fluid coming from the cells of the mastoid. It must be understood that fracture of the base may exist when there is no flow of blood or of serous fluid. A fracture of the middle fossa is usually compound, made so, even when the drum is not ruptured, by the Eustachian tube. In fracture of the posterior fossa blood accumulates beneath the deep fascia and produces discoloration in the line of the posterior auricular artery (Battle's sign), the discoloration first appearing near the tip of the mastoid. The discoloration appears in the line of nerves and vessels which emerge from the deep fascia, the vessels passing through openings and the extravasated blood emerging from the same openings. Fractures of the posterior fossa are apt to be compound through the pharynx, and in such cases the patient spits or vomits blood. Compound fractures of the posterior fossa are more fatal than fractures in either of the other fossæ. Fractures of the base are apt to be associated with paralysis of cranial nerves. Optic neuritis often arises after the first week. Keen says that in fractures of the base the temperature is subnormal during the shock, rises to 100° to 101°, falls again to a little below normal, and remains normal or subnormal unless there be inflammation or sepsis.

Treatment.—In treating a compound fracture of the base of the skull, collect any serous discharge and analyze it, and disinfect any cavity involved. In fractures of the middle fossa with ruptured drum clean the ear mechanically, wash it out with hydrogen peroxid and with a stream of warm corrosive-sublimate solution of a strength of 1 : 2000 (turn the head toward the affected side while washing, so that the mercurial solution will not run down the Eustachian tube), pack with

[1] *Edinburgh Med. Jour.*, Nov., 1895.

iodoform gauze, and apply an antiseptic dressing. Several times daily the ear is to be irrigated, and insufflated with iodoform. The nasopharynx must be frequently irrigated with normal salt solution or boric-acid solution, and insufflated with iodoform. The conjunctival sac is frequently irrigated with boric-acid solution. If after a head-injury blood accumulates back of the drum, this membrane should be incised to permit of drainage and disinfection. In fractures of both the middle and anterior fossæ the nasopharynx must always be cleaned. The exact method depends on the choice of the surgeon. We may wash out these cavities frequently with hot water, next with peroxid of hydrogen, and finally with boric-acid solution, or can use normal salt solution. Insufflate the nasopharynx with iodoform, and pack the nose with iodoform gauze (Keen, Dennis); also cleanse the conjunctival sac frequently. In some cases drainage has been obtained from the anterior fossa by breaking down the cribriform plate and introducing a tube through the nostril (Allis), and from the middle fossa by trephining above and behind the external auditory meatus. In a compound fracture of the orbit disinfect and drain. It may be necessary to trephine the roof of the orbit for drainage. In fracture of the posterior fossa examine to see if the fracture is compound, into the pharynx, and if it is cleanse with great care the nasopharynx, and mouth, as previously directed. In a very extensive fracture of the base, besides use of the methods set forth above, the entire head should be shaved and a plaster cap be applied. Cases of fracture of the base must be put into a quiet and darkened room and be kept upon a low diet, sleep being secured, and the bowels and bladder being attended to. If we are not sure whether a fracture exists or not, keep the man quiet and in a darkened room, and on a low diet. Attend to the bladder, keep the bowels loose, examine the nasopharynx with mirrors and the drum through a speculum.

Wounds of the brain are produced by violence and by foreign bodies (knives, bullets, etc.). Except when due to penetration of a fontanelle in a child or of a parietal foramen in adults, wounds of the brain are accompanied by fracture of the skull. These wounds are very dangerous: foreign bodies (bone, hair, clothing, etc.) are often lodged in the brain, hemorrhage is usually severe, and sepsis is almost inevitable without proper treatment. These cases are very fatal, though some astonishing recoveries are on record.

The **symptoms** of brain-wounds may be slight and long-

deferred or may be immediate and overwhelming; they depend upon the site and extent of the injury. Localizing symptoms may exist, and encephalitis with coma is apt to arise. Abscess not unusually follows.

In treating wounds of the brain always shave the entire scalp and examine the weapon, if possible, to see if a piece were broken off. Asepticize, enlarge the wound, trephine, arrest bleeding, elevate any depression, remove foreign bodies, irrigate the wound, suture the dura, drain, and dress.

Gunshot-wounds of the Head.—A *penetrating* wound is one in which the bullet enters the head, but does not emerge; a *perforating* wound is one in which the bullet passes through the head and emerges. The bullet of the modern rifle will rarely lodge, but a pistol-bullet will often lodge. The wound of entrance is small; the wound of exit is large. At the wound of entrance the inner table is more extensively fractured than the outer table; at the wound of exit, the outer table is more widely broken than the inner table. In these cases there is always great concussion, and concussion-symptoms exist even when the bullet has not entered the brain. In moderate concussion the action of the heart is retarded; in severe concussion it is accelerated.[1] A bullet may be lodged within the cranium when merely a fracture without a bullet-hole can be detected. In these cases the bullet produces a fracture and enters the cranium, and then the depressed bone flies back into place (v. Bergmann). In such cases if complete perforation occurs, the one existing opening is the opening of exit. A bullet may lodge in the bone, between the dura and the bone, in the brain, between the dura and bone of the opposite side, or in the bone of the opposite side, in the nasal fossa, maxillary antrum, or orbit. Always examine the side of the head opposite to the wound of entrance to determine if there is any bulging or fracture. A bullet may pass or cross the brain and be deflected from the inner surface of the skull (Fluhrer). Ruth does not believe the bullet can rebound from the opposite wall.[2] The secondary **symptoms** of gunshot-wounds of the head are varied and uncertain, and may not be observed at all before death. Fowler wisely points out that a patient with a gunshot-wound of the head may have also received other injuries, and the other injuries may be in part, at least, responsible for cerebral symptoms.

[1] Fowler, in *Annals of Surgery*, Nov., 1895.

[2] See the instructive article by Fowler, in *Annals of Surgery*, Nov., 1895.

Treatment.—Bring about reaction (see Concussion). In severe cases apply heat to the head, and make artificial respiration. It will sometimes be necessary to operate while artificial respiration is being made. In treating gunshot-wounds of the head shave and asepticize the whole scalp, disinfect the entire track of the ball, and arrest hemorrhage at the wounds of entrance and exit, using the rongeur to expose the bleeding points if the bullet be large, employing the trephine if it be small. If the bullet has emerged and has been picked up, examine it to see if it is entire. The bullet, if retained, is to be sought for. Place the head in such a position that the track of the ball will be vertical, then introduce Fluhrer's aluminum probe and let it find its way by gravity. The probe may find the ball near the wound of entrance, in which case extract the ball with forceps; or the probe may find the ball near the opposite side of the head, in which case make a counter-opening through the bone at a point the probe would touch if it were pushed entirely across. Take a new and *clean* rubber catheter (No. 9, French), insert a stylet, and carry the catheter through the wound (Keen). Knowing the depth of the ball, search for it around the catheter-tube as an axis, and when found extract it. After extraction drain the wound by means of a tube. When a counter-opening exists drain through and through. If the ball cannot be detected, drain by a tube carried to the depths of the wound. After dressing always place the head in a position favorable for drainage. Fluhrer tells us that when a counter-opening fails to disclose the bullet, use the new opening as a doorway through which to search for the ball. He believes the bullet is not unusually deflected. The angle of reflection is somewhat greater than the angle of incidence, and the bullet is apt to fall a little toward the base. Splinters of bone are often driven into the brain by a bullet, and these are removed whether the ball is found or not. Several varieties of probes have been commended. Fluhrer uses a large-sized aluminum probe. Senn uses an instrument shaped like the Nélaton probe, but of the same diameter as the bullet. (Of course, the porcelain probe will not show a black mark from contact with a modern bullet.) Fowler uses a graduated pressure-probe; so long as the pressure is within the limits of the spring, as shown by the scale, the probe is in the bullet-track. Girdner's telephonic probe is a valuable aid to diagnosis. Recently bullets have been located by the Röntgen rays. There can be no doubt that many gunshot-wounds have

been recovered from without operation, and there can be no doubt that many deaths follow operation (about $33\frac{1}{3}$ per cent., according to Hahn). Von Bergmann is so impressed with these facts that he does not operate when symptoms are absent.

Fungus cerebri (hernia of the brain) rarely contains true brain-substance. It is in most instances a growth from the neuroglia. Hernia cerebri cannot occur if the dura is not opened; it is rare in any case unless the brain is damaged, and is most frequent after septic wounds. In any brain-operation where the dura is opened suture it; or, if there be a great gap in the dura, turn in a flap of pericranium, its bone-forming surface being upward, and stitch this membrane to the dura (Keen). The evidence of brain-hernia is a protruding mass which is soft, lobulated, of a dirty-white color, pulsating, painless to the touch, often bleeding, and sometimes discharging cerebrospinal fluid. In treating brain-hernia employ antiseptic dressings. Skin-grafting benefits some cases. Pressure is dangerous. Excision by the knife or cautery does no good. After healing, a depression marks the site of the hernia.

Traumatic inflammation of the brain and its membranes is divided into *encephalitis* or *cerebritis*, inflammation of the cerebrum; *cerebellitis*, inflammation of the cerebellum; *meningitis*, inflammation of the meninges; *arachnitis*, inflammation of the arachnoid; *pachymeningitis*, inflammation of the dura; and *leptomeningitis*, inflammation of the arachnoid and pia.

Pachymeningitis.—Inflammation of the external layer of the dura is called pachymeningitis externa. It may arise from tumor, caries, necrosis, middle-ear disease, sunstroke, or traumatism. Syphilis is a not unusual cause. The other membranes may become involved. Suppuration may arise, having extended by contiguity from neighboring parts. The **symptoms** of pachymeningitis externa are uncertain. They resemble often those of leptomeningitis (page 673). Pressure-symptoms may arise. Headache is always present. Paralysis may or may not exist. If pus forms, the ordinary constitutional symptoms of suppuration arise (high temperature and sweats), not the symptoms of abscess in the brain. In a severe case the other membranes become involved.

The **treatment** consists in removing the cause (carious bone, pus, middle-ear disease). In pachymeningitis from traumatism it is sometimes advisable to trephine in order to drain inflammatory products; in a case with localizing

symptoms always trephine; in an ordinary case, without pus and with no evidences of traumatism, use wet cups back of the mastoid processes, apply an ice-bag to the head, and purge by means of calomel. Use iodid of potassium in most cases. If sunstroke is the cause, treat accordingly.

Pachymeningitis interna may extend from the pia, or may extend from the outer layer of the dura. The form known as *hematoma* of the dura mater, or pachymeningitis interna hæmorrhagica, may arise during infectious diseases (typhoid fever and rheumatism), in persons of the hemorrhagic diathesis, in diseases causing atrophy of the brain, in chronic diseases of the heart and kidneys, and in syphilitics. Among the exciting causes are traumatism, inflammation in adjacent parts, and, especially, the abuse of alcohol. In this disease blood is extravasated on the inner surface of the dura. Many observers do not class hemorrhagic pachymeningitis as inflammation, but regard the hemorrhage as primary.

The **symptoms** of internal pachymeningitis are very chronic, are not characteristic, and may be absent. They consist usually of persistent headache and apoplectiform attacks, with contraction of the pupil, slow pulse, and vomiting. Choked disk is not infrequent, localizing symptoms may be made out, and coma is apt to arise.

The **treatment** is the same as that for external pachymeningitis.

Acute leptomeningitis is a purulent inflammation of the soft membranes of the brain. The pathological changes can be noted in the pia and in the brain-substance. The brain is edematous, the pia purulent, the convolutions are flattened, the ventricles are distended with fluid, and hemorrhages occur into the brain-substance. Pus may be localized upon the pia, but it is usually diffused over one hemisphere or over both. Various organisms may be found, especially streptococci, staphylococci, and diplococci. In some cases we find the bacillus pyocyaneus or the bacillus pyocyaneus fœtidus, which is identical with the colon bacillus and with the bacillus meningitis purulenta (Park). Saprophytic organisms are occasionally present. This disease may be acute or chronic, and a severe case is spoken of as encephalitis. Secondary leptomeningitis is apt to affect the convexity; primary leptomeningitis is apt to affect the base (Hirt).

The **causes** of leptomeningitis are epidemic cerebrospinal fever, tuberculosis, acute general diseases (pneumonia, typhoid, erysipelas, and rheumatism), bone-diseases,

traumatisms, middle-ear disease, syphilis, and sunstroke. The tissues of the pia and the cerebrospinal fluid contain diplococci identical with pneumococci. Infection may take place by various avenues. It may pass from the nose by way of the Eustachian tube to the ear, or from the nose to the frontal sinus or ethmoid sinuses (Hirt), and from these situations to the brain. It may pass from the middle ear or mastoid to the membranes of the brain. In fractures at the base the organisms enter by way of the pharynx and the Eustachian tube, or the ear. The **symptoms** of acute leptomeningitis are violent headache persisting during delirium, flushing of the face, rigidity of the neck, cerebral vomiting, a slow pulse, elevated temperature, photophobia, contraction of the pupils, intolerance of sound, hyperesthesia of the skin and muscles, and delirium passing into stupor and coma. A chill or a succession of chills may occur. Choked disk, strabismus, and nystagmus are not unusual. Convulsions or paralyses may occur. Death is the rule within one week. The **treatment** usually consists of purgation with calomel; bleeding behind the mastoid processes; cold to the head; warm baths with cold affusions to the head; iodid of potassium, bromid of potassium, or morphin for vomiting and headache. Some surgeons trephine in order to relieve pressure and to give exit to inflammatory products, and this procedure should be employed. It gives some hope of recovery, and the usually adopted medical treatment is practically useless; should the patient recover, he is guarded for a long time from physical exertion, mental excitement, worry, irritation, constipation, and insomnia.

Chronic Leptomeningitis (or Encephalitis).—The **causes** of chronic leptomeningitis are the same as those of the acute form. If traumatism is the cause, the inflammation arises at a later period than it would in acute encephalitis. The **symptoms** of concussion follow a head-injury. Days, or even weeks, after the accident, a series of symptoms occur—namely: localized pain at the seat of injury, often accentuated by tapping; listlessness; irritability; apathy regarding business affairs and home obligations, or profound depression and hypochondria with inability to attend to business. Choked disk may exist. In any case acute encephalitis may arise, with or without a chill. The **treatment** of this disease is symptomatic unless local symptoms exist. Always operate if localizing symptoms are found. Intense local pain justifies trephining.

Tubercular Meningitis (Acute Hydrocephalus; Water

on the Brain).—This inflammatory condition is due to the bacilli of tuberculosis. In a child affected with meningitis there is often a record of a fall, the injury acting as an exciting cause by establishing an area of least resistance. Prodromal symptoms are common (restlessness, irritability, anorexia, change of character). The disease begins with a convulsion or with headache, fever, and vomiting (Osler), the child cries out from pain (the hydrencephalic cry), and the bowels are constipated. The pulse is rapid in the beginning, but later becomes slow and irregular. The pupils are contracted, there is muscular twitching, and the sleep is impaired. The temperature is about 103°. In the second period of the disease the vomiting ceases, constipation becomes more marked, the belly retracts, headache is not so violent, and the patient lies in a soporose condition interspersed with episodes of delirium. In this stage the pupils dilate and are often unequal, the head is retracted, convulsions occur or limited rigidity is noted, the respirations are sighing, and if a fingernail is drawn along the skin, a red line develops (the *tâche cérébrale*, due to vasomotor paresis). Squint and consequent double vision are usual. In the last stage coma becomes absolute and general convulsions or limited spasms are apt to occur. Optic neuritis exists, and the child passes to death along a road identical with that of typhoid collapse. In some cases the examination of cerebrospinal fluid withdrawn by lumbar puncture throws light upon the diagnosis. In children the base is usually involved, and the disease is apt to last from two to four weeks; in adults the convexity of the brain is usually involved, and death is apt to occur in a few days.

The **treatment** is like that for traumatic meningitis.

Abscess of the brain is a localized collection of pus. The organisms found are noted upon page 673 (Acute Leptomeningitis). The **causes** are suppurative otitis media (in half of all the cases), fracture of the skull, concussion of the brain, and general septic diseases. A tubercular mass may caseate (tubercular abscess). The abscess may be between the dura and skull (extradural), adhesions forming and preventing a general leptomeningitis, between the dura and brain (subdural), or in the brain-substance (cerebral or cerebellar). Leptomeningitis may arise because no adhesions form, because septic clot forms in veins or sinuses, or because infected blood regurgitates in sinuses (Park). A traumatic abscess is generally beneath the area to which the traumatism was applied, but it may be on the

opposite side. The infection may begin in the nose (page 668), the orbit, or the middle ear. Roswell Park says infection may pass along blood-vessels, lymph-vessels, nerve-sheaths, or the prolongations of the membranes which extend outside of the skull. An acute inflammation of the middle ear rarely causes abscess, because an acute inflammation in sound tissues causes the formation of granulation-tissue, which acts as a barrier to infection. Chronic inflammation of the middle ear is the most frequent cause of abscess. Park tells us if the roof of the tympanum is involved, it is perforated and abscess of the middle fossa ensues; if the roof of the tympanum is perforated toward the mastoid antrum, the abscess arises in the temporosphenoidal lobe; if the perforation is toward the sigmoid groove, the abscess forms in the cerebellum.[1]

Symptoms of Abscess of the Cerebral Substance.—The symptoms due to pus-formation are as follows: there may be an initial rise of temperature, but (except in extradural abscess) the temperature quickly becomes normal or subnormal. Toward the end of the case the temperature may rise and the fever become linked with delirium. Surface elevation of temperature over the seat of the abscess is occasionally observed. A chill may or may not occur. Anorexia and vomiting are present. Urinary chlorids are diminished and the phosphates are increased (Somerville). Symptoms due to pressure are—headache (which at first is general, then local, and grows worse later in the case, and exists even in delirium: this fact distinguishes it from the headache of fever, which ceases in delirium); pulse is very slow; respiration tends to the Cheyne-Stokes type; drowsiness lapses into stupor and stupor passes into coma; paralysis of the sphincters takes place; convulsions are common; sensation is rarely impaired; and paralysis of the basal nerves may occur (third and sixth especially). The pupil on the same side as the abscess is dilated and fixed. Choked disk is not invariably found; if it is unilateral, it is on the same side as the abscess; if it is bilateral, it is more marked on the same side as the abscess. Localizing symptoms, spasmodic and paralytic, depend upon the center which is irritated or destroyed. In cerebellar abscess there are vertigo, vomiting, occipital headache, rigidity of the post-cervical muscles, and incoordination. Choked disk is often absent.

Meningitis arises soon after an accident; an *abscess*, more

[1] Park, in *Chicago Med. Record*, Feb., 1895.

than a week, often many weeks, after an accident. Meningitis presents high temperature and the general symptoms before outlined. *Mastoid disease* may occasion cerebral symptoms without abscess, or it may cause abscess. In *sinus-thrombosis* there is septic temperature, the veins of the face and neck are enlarged, and a clot can usually be felt in the jugular. A *tumor* grows slowly, usually presents almost from the start distant localizing symptoms, and double choked disk is frequently present. In tumor the temperature is apt to be normal.

Treatment.—If abscess is due to ear disease with implication of the mastoid cells, at once open the mastoid, and after this proceed to trephine the skull in order to reach the abscess. In any case, if symptoms of abscess exist, trephine the skull at once. If localizing symptoms are present, open over the suspected region. If localizing symptoms are not present and the cause is ear disease, trephine at Barker's point (Fig. 246). If no pus is found between the bone and dura, open the membrane. When the dura is opened, if the abscess is subdural pus will be evacuated; if the abscess is in the brain-substance, the brain will bulge very much and will not be seen to pulsate. A grooved director is plunged into the brain, in the direction of the abscess, for two or two and a half inches (Keen). If pus is not found, withdraw the director and introduce it at another point. When pus is discovered incise the brain with a knife, enlarge the opening by inserting a closed pair of forceps and withdrawing the instrument with the blades open. Scrape away the granulation-tissue lining the abscess-cavity, irrigate with hot salt solution, and introduce a rubber drainage-tube; stitch the dura, but leave an ample opening for the tube; bring the tube out through a button-hole in the scalp, and after the first two days pull the tube out a little every day and cut off a piece. If the first trephining does not find pus, trephine again at another point. In cerebellar abscess make a flap with the base up, and trephine or gouge away the bone just below the line of the lateral sinus. Puncture the brain as for cerebral abscess.

Brain Disease from Suppurative Ear Disease.—Chronic disease of the middle ear is apt to destroy the bone between the tympanum and the middle fossa of the skull, and thus produce meningitis, thrombosis of the petrosal or lateral sinuses, abscess of the temporosphenoidal lobe or of the cerebellum, or extradural abscess. Chronic otitis media also induces inflammation or suppuration of the mastoid

cells (empyema of mastoid). Pus in the mastoid may discharge itself into the middle ear, and from this point into the external auditory canal, through a perforation in the drum-membrane (especially in acute cases). In some cases the pus becomes blocked up within the mastoid process. Pus in the mastoid may after a time break into the cavity of the cranium or into the lateral sinus, or may find its way externally and open into the sheaths of muscles arising from the mastoid. It not unusually opens into the sheath of the digastric muscle (Bezold's abscess). These facts teach the surgeon that chronic ear disease should never be neglected, but should, if possible, receive the closest attention of the specialist. If no perforation exists in the drum, the surgeon must make one. In ordinary cases cleanliness and antisepsis are sufficient, the ear being syringed every day with a warm 2 per cent. solution of common salt. If only a small drum-perforation exists, 10 drops of pure alcohol or of corrosive-sublimate solution (1 : 5000) are dropped into the ear daily; but if a large drum-perforation exists, boric acid and iodoform (7 to 1) are insufflated. Never inject alum. A strong silver solution is not safe; if it is used, wash the ear out afterward with warm salt water. If granulations or polypi exist, they must be removed (Burnett). Some cases require the removal of the drum-membrane and the ossicles of the ear. Many cases of mastoid necrosis are due to tuberculosis. If headache, vomiting, and mastoid tenderness exist, open the mastoid (see Operations), in order to prevent abscess of the brain. In acute otitis media it is very rarely necessary to open the mastoid. The middle ear is on a lower level than the antrum of the mastoid, and in most acute cases both the middle ear and mastoid cells drain safely through a drum-perforation. Because a man has chronic otitis media it is by no means always necessary to trephine the mastoid. In many cases removal of the ossicles and drum-membrane effects a cure. In chronic otitis media, even if the mastoid is trephined, the ossicles and membrane ought to be removed.

Cerebral abscess from ear disease is almost always in the temporosphenoidal lobe, but may arise in the cerebellum. The **symptoms** are a transient rise of temperature followed by a subnormal temperature; vomiting; mastoid, frontal, and temporal pain. The mind is dull, and stupor arises which passes into coma; the bowels are constipated; choked disk may be present; and convulsions or spasms or paralyses may exist. Trephine and clean out the mastoid,

and asepticize (see Operations upon the Skull and Brain). Trephine at Barker's point, one and one-fourth inches behind, and the same distance above, the middle of the external auditory meatus. If pus is not found, open the cerebellum.

Extradural Abscess.—The eye-symptoms and pain are the same in this as in cerebral or subdural abscess, but the temperature is different, rising to 103° or 104° F. There is often considerable tenderness above and behind the mastoid. In extradural abscess following disease of the middle ear, trephine and clean out the mastoid; follow up a bone-sinus to the abscess, rongeur away the bone, being careful to avoid injuring the lateral sinus, curet, irrigate, and drain.

Infective Sinus-thrombosis.—Any sinus may be attacked. In erysipelas of the scalp, septic clots may form in the veins which pass through the bone and reach the longitudinal sinus. Infective thrombosis of the superior longitudinal sinus is thus produced.

In carbuncle of the lip and orbital suppuration the cavernous sinus may become involved.

In caries of the basilar portion of the occipital bone the circular sinus or the cavernous sinus may suffer. In caries of the petrous portion of the temporal bone, and in suppuration of the middle ear and mastoid process, infective thrombosis of the lateral sinus may occur.

In any case the symptoms are those of pyemia. The lateral sinus is the one most frequently attacked. In infective thrombosis of the lateral sinus there is usually a history of an old discharge from the ear.

The **symptoms** of this disease present a history of chronic ear disease. Headache and pain over the sinus arise; violent rigors occur; and the temperature rises and fluctuates greatly. The patient is nauseated, labors under vertigo, is very restless; is dull and stupid, sometimes delirious; and the muscles of the neck are stiff. Tenderness and marked edema are detected over the mastoid. When the clot extends into the jugular vein there is pain on moving the head and on swallowing, the cervical glands are swollen, and a clot may be felt in the neck. Exophthalmos and swelling of the eyelids point to involvement of the cavernous sinus in the process. Choked disk exists in about half of all cases. There is often a profuse discharge of pus from the ear, but in some cases the discharge is found to have abated or ceased. In early cases there is thrombosis of the lateral sinus alone, or of the lateral sinus and jugular vein. In advanced cases

other sinuses become involved (superior petrosal, inferior petrosal, both cavernous, the lateral sinus of the opposite side, the ophthalmic veins, and the torcular Herophili). A patient with sinus-thrombosis is in great danger of developing pulmonary metastasis and septic meningitis (Jansen). Septic meningitis is accompanied by abscess about the sinus.

The **prognosis** largely depends upon early recognition. The surgeon should open a mastoid before sinus-thrombosis arises, and should evacuate a perisinous abscess before a clot forms in the sinus, or at least before that clot becomes septic (Jansen).

Treatment.—Infective thrombosis of the lateral sinus is treated as follows: open and clean out the mastoid, and expose the sinus by the use of the chisel or rongeur (Fig. 246). Open the sinus, and if a clot is found to exist cut away the wall of the sinus. Introduce a small spoon into the sinus and carry it toward the torcular Herophili, and scrape away the clot until blood flows. Arrest hemorrhage by plugging a piece of iodoform gauze into the wound and toward the torcular. Jansen opposes removing the entire clot toward the jugular, and does not tie the jugular, believing that to do so increases the danger of thrombosis of the inferior petrosal and cavernous sinuses. Influenced by these views, Jansen removes the soft clot, but does not disturb the solid clot toward the heart. Most surgeons differ with him, and after opening the sinus, turning out the clot and packing, proceed to ligate the jugular vein at the level of the cricoid cartilage. If, after this operation, the clot in the jugular becomes septic, incise the vein up to the base of the skull and pack. It is obviously futile to do any operation if pulmonary metastasis has taken place, although in a recent case in the Jefferson Medical College Hospital the patient recovered after operation in spite of the fact that endocarditis had developed.

Until recently it was thought that the lateral sinus was the only sinus which should be attacked surgically, but in a recent case Knapp of New York requested Hartley to remove from the cavernous sinus a clot which was causing blindness. The operation was successfully executed by Hartley, the incision being the same as is employed to reach a Gasserian ganglion in the Hartley-Krause operation.

Intracranial tumors may be true neoplasms, may be of parasitic origin, may result from injury, may be tubercular or syphilitic. Among these tumors are papillomata, gliomata, sarcomata, choleostomata, fibromata, psammomata, myxomata, osteomata, etc. (see Tumors). Cysts sometimes

occur. The **symptoms** are diffuse and local, and are similar in many particulars to the symptoms of some other lesions. Among the symptoms of tumor are headache, slow speech, stupor or coma, slow pulse, pain on percussion of the cranium, vertigo, vomiting, epileptic convulsions, double choked disk, partial or complete blindness, extensive or limited paralyses, paralysis of the face, the eye-muscles, or the limbs, zones of anesthesia and aphasia, word-deafness, word-blindness, agraphia, inco-ordination, and mental disturbances. The situation of a tumor is determined from localizing symptoms, their mode of onset and manner of combination. In some cases the symptoms are not characteristic, and in some cases there are no localizing symptoms. The nature of the tumor, its depth, and whether it is single, and if other tumors exits, is, if possible, determined. Localizing symptoms may be due to irritation or destruction of functionating power. Irritation causes spasm and destruction induces paralysis. Convulsions which are local or which begin locally are known as Jacksonian epilepsy. A local convulsion points to an irritative lesion of, or immediately adjacent to, the center which presides over the muscular movements of the part convulsed. Local paralysis points to a destructive lesion of the center which presides over the movements of the paralyzed part. In some cases a center is damaged and the muscular movements it controls are paralyzed, but the adjacent brain-areas are irritated and the muscles they represent are attacked with spasms. In some cases an apparently paralyzed part becomes convulsed, the center not being completely destroyed and sudden hyperemia serving to awaken spasm. Always note the order of invasion of different regions and observe if spasm is followed by muscular weakness or anesthesia.

1. **Lesions in the Cortical Motor Area.**—An irritative lesion of the lower third of this area causes spasm of the opposite side of the face, angle of mouth, or tongue; and this condition is often associated with tingling (Osler). The spasm may remain limited or may extend widely, and may even become general. Tumors of the third frontal convolution of the left side cause motor aphasia. An irritative lesion of the middle third of the cortical area causes spasm, which is limited to or begins in the fingers, thumb, wrist, or shoulder (Osler). An irritative lesion of the upper third of the cortical motor area causes spasm, which is limited to or begins in the toes, ankle, leg, or hip. If such lesions exist an aura is occasionally felt in the affected region before the

spasm begins, and there is often numbness after the spasm. Destructive lesions of the motor area cause local paralysis, which may be preceded by local spasm of the same parts, and is often associated with local spasm of other parts.

2. **Tumors of the prefrontal region** give no localizing symptoms, but produce general symptoms. Mental disorders are apt to occur. As the tumor grows it may subsequently involve the motor region.

3. **Tumors of the parieto-occipital lobe** may occupy a silent region of this lobe. There may be blindness or paraphasia when the angular gyrus is affected.

4. **Tumors of the occipital lobe** produce homonymous hemianopsia.

5. **Tumors of the temporosphenoidal lobe** frequently produce no symptoms. Tumors in the left lobe may cause deafness.

6. **Tumors** of any size in or about the **corpus striatum** cause hemiplegia by pressure upon the internal capsule. Pressure upon the optic thalamus produces hemianopsia and hemianesthesia. Growths near the basal ganglion produce intense optic neuritis and early pressure because of distention of the ventricles. Osler tells us that tumors of the corpora quadrigemina are apt to involve the crura, and later the third nerve. Ocular symptoms are always present (loss of pupillary reflex and nystagmus). If the third nerve is involved, there are paralysis of the motor oculi area on the side of the lesion (external strabismus, dilated pupil, and drop lid), and hemiplegia of the opposite side of the body from pressure upon the crus. This condition is a form of crossed paralysis.

7. **Tumors of the Pons.**—Pontine lesions produce symptoms by pressure upon the particular nerves which come from this region, with or without the evidences of pressure upon the motor path. Forms of crossed paralysis may exist. Lesions in the lower half of the pons may affect the fifth, sixth, and seventh nerves on the side of the lesion, and the limbs on the opposite side. The auditory nerve may be involved in the lesion. In crossed paralysis the face on the side of the limb paralyzed is usually not affected, but in extensive tumors it may be paralyzed. Conjugate deviation may occur *away* from the *facial paralysis.* In tumors of the upper part of the pons the pupils may be first contracted from irritation of the third nuclei, and later dilated from destruction of these nuclei. Anesthesia as a result of pontine tumors is not nearly so common as is motor paralysis, and convulsions are rare.

8. **Tumors of the Medulla.**—An extensive lesion inevitably causes death. Cranial nerves only may be involved, but crossed paralysis may take place. Vomiting is common, retraction of head is not unusual, respiratory and circulatory disturbances and dysphagia are frequently noted; sometimes there is numbness, and occasionally there are convulsions; usually there is inco-ordination, because of pressure upon the cerebellum.

9. **Tumors of the Cerebellum.**—*Tumors of the middle peduncle* cause sudden uncontrollable movements of the trunk, either toward the side of the tumor or away from it. Vertigo and nystagmus are common. Symptoms are frequently complicated by evidences of pontine disease proper.

Tumors of the middle lobe of the cerebellum cause a sense of lost equilibrium and obvious unsteadiness in attempting to walk, or even to stand (Gowers). The patient has a tendency to fall; there are giddiness and vomiting.

Tumors of the cerebellar hemispheres produce no localizing symptoms. The usual unsteadiness of gait is due to pressure upon the middle lobe (Nothnagel).[1]

Treatment.—If any doubt exists as to the nature of a brain tumor, give the patient a course of iodid of potassium, and as doubt is the rule, we almost invariably administer it. Give at first in small amounts, but rapidly increase it until heroic doses are taken (100 or more grains a day). Mercury should also be given hypodermatically. If iodid of potassium and mercury relieve the symptoms, operation is unnecessary, although it may be demanded later in order to remove an irritant scar. If antisyphilitic treatment fails, the question of operation must be considered. In many cases of undoubted tumor excision for cure is not attempted because of the absence of localizing symptoms or because of the inaccessible situation of the growth. Tumors at the base, tumors of the pons and medulla, of the corpus callosum, of the basal ganglia, of the deeper parts of the centrum ovale, are irremovable (Byrom Bramwell). Most tumors of the cerebellum should not be attacked. In tumors which are very extensive complete removal is usually out of the question. There is no use in removing secondary malignant tumors. It often happens that the brain itself (as in syphilis) is so extensively diseased, or that other organs (as in tuberculosis) are so involved, as to render attempts at removal

[1] For full consideration of localizing symptoms, see the works of Gowers and Osler, which have been freely used in writing the above section.

futile. Bramwell tells us[1] that he has studied eigthty-two cases of intracranial tumors, and he considers that in only five of them could the tumor have been entirely removed. The conclusion is that though some tumors of the brain may be successfully removed, extirpation is only to be decided on after careful study of all the indications and contraindications offered by the case. The fibromata constitute the best cases for operation. In cases not operated upon it may be necessary to use the bromids for convulsions and morphin for headache. The headache is often benefited by purgatives, courses of potassium iodid, the ice-bag to the head, and the application of a hot iron to the nape of the neck. Though thorough extirpation is feasible in but few cases, operation should often be performed for palliative purposes. Grainger Stewart, Annandale, Horsley, Macewen, and Keen have advocated palliative trephining in certain cases.

This procedure is of value in diminishing excessive intracranial pressure, and thus relieving headache and decreasing the tendency to sudden death from inhibition of the heart or respiratory failure (Hughlings Jackson and Byrom Bramwell).

Palliative trephining may relieve optic neuritis, and thus retard or prevent atrophy and blindness. Bramwell asserts this positively, and he still believes that excessive intracerebral pressure is an important element, though not the only element in neuritis.

Most cases of tumor should be trephined for exploration; in some cases extirpation may be performed; in most cases extirpation is impossible, and the surgeon must be content with the palliative influence of trephining. A tumor of the brain if not cured by antisyphilitic treatment, is of necessity fatal if unoperated upon, and trephining is not a very dangerous operation. After palliative trephining, make an attempt to obtain prolonged drainage of cerebrospinal fluid.

Operative Treatment of Epilepsy.—The shock of an accident or a general concussion may establish epilepsy, especially in those predisposed by heredity or other causes. Traumatic epilepsy, Le Dentu tells us,[2] may be due to: (1) bone-fragments from skull-fracture; (2) outgrowths of bone due to tumor; (3) cicatrices of meninges resulting from laceration of membranes by bone-fragments; (4) chronic meningitis which ends in sclerosis of membranes; (5) cysts resulting from intracranial hemorrhage at the point

[1] *Edin. Med. Jour.*, June, 1894.
[2] *La Presse médicale*, June 9, 1894.

of fracture; (6) arteriovenous aneurysm. We refer here, in speaking of traumatic epilepsy, purely to the condition when it follows a head-injury, and this is the common meaning of the term. Remember that epilepsy, as shown by Sachs, may follow a long-forgotten injury. When epilepsy has followed traumatism and a scar exists upon the scalp, excise the scar, especially if it is tender or is the seat of an aura. If, on lifting the scalp, a depression of bone or a disease of the bone is manifest, trephine for exploration, even over a silent area. Trephining in epilepsy may disclose a cyst, a dural scar, a brain-scar, a depressed portion of bone, or eburnation of bone from osteitis (Keen). In exploratory operations for epilepsy always open the dura. When the injury is over a known motor center it is important to trephine. This operation is especially indicated when the convulsions begin in the muscles of this center, in which case it is proper to remove the center after trephining. Remove all sources of peripheral irritation (Briggs reported a case of epilepsy in which there were distinct skull-depression and necrosis of the tibia, but the cure of the necrosis of the tibia arrested the convulsions). If epilepsy arises notwithstanding primary trephining, open the flap, round the bony edges with a rongeur, and cut out the scar.[1]

These operations sometimes seem to cure epilepsy, but so, occasionally, does any operation. White records[2] ninety trephinings in which, though no cause was found for the epilepsy, great relief followed, and two cases were apparently cured; he mentions benefit or apparent cure following tracheotomy, ligation of the carotid artery, incision of the scalp, etc. The same effect may be obtained by a great shock, high fever, the administration of an anesthetic, or an accident. The fact seems to be that any operation, by means of nervous shock, may interrupt the epileptic habit; but in ordinary operations the fits tend after a time to recur, and soon reach their old standard of frequency. In the special brain-operations with excision of obvious lesions or discharging centers the fits usually recur, but they will rarely reach the old standard of frequency, and will be more amenable to medical treatment. Bramwell says that when traumatism is followed by epilepsy and the epileptic discharge starts from a cortical center which is not beneath the scar, trephine first at the seat of injury, and if no lesion is met

[1] The author, in Hare's *System of Practical Therapeutics.*

[2] "The Supposed Curative Effects of Operations *per se*," *Annals of Surgery*, August and September, 1891.

with trephine over the discharging center. In epilepsy the fits are to be studied by a competent observer (Keen) and, if focal epilepsy or Jacksonian epilepsy exist, and treatment by drugs has failed, trephining is to be performed over the diseased center and the explosive focus is to be located by an electric current and removed. Keen, Horsley, Nancrede, Macewen, and others practise this, but hope for improvement rather than expect cure. This operation causes paralysis, but the paralysis is rarely permanent, except, perhaps, of the finer movements.

In non-traumatic chronic epilepsy without localizing symptoms trephining is not justifiable unless persistent headache calls for it as a means of relief from intracranial pressure. Annandale has recently advised us to consider experimental operation in such cases when the drug-treatment has failed and when the patient's condition seems hopeless. He says there is no chance of improvement without operation, and operation may possibly disclose a removable lesion.[1] After trephining for epilepsy five years should elapse without a convulsion before cure is reasonably assured; and if convulsions arise, they must at once be met by medical treatment. A man having once had a convulsion may at any time have others; hence he should always be watched. It is not unusual for a few convulsions to occur soon after an operation for epilepsy, and then to cease for a considerable time. These early fits result from habit. Among the operative procedures suggested for the treatment of epilepsy may be mentioned circumcision, clitoridectomy, ocular tenotomy, ligation of the vertebral arteries, removal of the cervical ganglia of the sympathetic (Alexander, Jonnesco, Jaboulay), and the actual cautery to the head (Féré).

Operations on the Skull and Brain.—Trephining (in a fracture of the skull).—Shave the scalp, scrub it with ethereal soap and sterile water, wash it with sterile water and then with alcohol or ether, scrub with a brush wet with corrosive-sublimate solution (1 : 1000), and wrap the scalp in wet corrosive-sublimate gauze (1 : 2000). The instruments required are a scalpel, a dissector, hemostatic, dissecting, and toothed forceps, trephines of several sizes (Figs. 244, 245), a periosteum-elevator, Hey's saw, rongeur forceps, a bone-elevator, a dural separator, a tenaculum, small curved and large curved Hagedorn needles, and a needle-holder, catgut, fine silk, silkworm-gut, and Horsley's wax. Provide a sand pillow. The patient should

[1] *Edin. Med. Jour.*, April, 1894.

be anesthetized unless he is unconscious, and is placed upon his back with the shoulders a little raised. A sand pillow is placed under the neck, and his head is turned away from the side to be operated upon. The position of the surgeon is such that the patient's head is a little to his left. A large semilunar incision is made with the base down, which incision goes through the periosteum, and the flap is lifted. The bleeding vessels of the flap are caught with forceps. The fracture is sought for and found. The pin of the trephine is projected beyond the crown and is set upon sound bone, the crown overhanging the line or edge of the fracture. The surgeon tries to avoid the region of a sinus or large artery. A gutter is cut in the bone, the pin of the instrument is withdrawn, and the trephining is completed. In going through the diploë bleeding is copious. The inner table

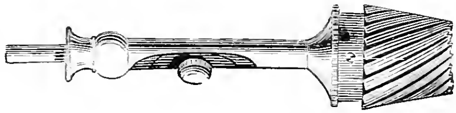


Fig. 244.—Galt's conical trephine.

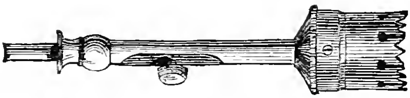


Fig. 245.—Crown trephine.

feels very dense. Stop from time to time, clean out the gutter in the bone with the dissector, and try the bone with an elevator to see if it is loose. When the fragment is loose enough, pry it out. If the surgeon desires to replace the button, hand it to an assistant, who places it at once in a bowl of solution of corrosive sublimate (1 : 2000), kept warm by standing in a basin of water at 105° F., or who puts it in warm carbolized towels or in warm normal salt solution. The edges of the opening should be rounded with a rongeur and the bone, if depressed, must be elevated. Sometimes it may be necessary to remove splinters and fragments of bone. After removing the fragments the edges of the opening should be smoothed by the use of the rongeur forceps. The dura should be examined to see if injury exists, and hemorrhage must be stopped. Bleeding from the dura is arrested by passing a ligature of silk or catgut under the

vessel on each side of the wound, and tying the ligatures. This is effected by means of a curved needle. Bleeding from the pia is arrested by direct ligation, or in the same way as is bleeding from the dura. Bleeding from the diploë is arrested by the use of Horsley's wax. The wound is cleansed, in some cases the button of bone is re-introduced, or some chips are cut from the bone and scattered upon the dura. The scalp is sutured with silkworm-gut and horse-hair or gauze drainage is employed for a day or two. Sterilized gauze dressings are put on, a rubber-dam is laid over them, and a gauze bandage wet with bichlorid of mercury is applied.

Instead of the trephine some surgeons use the chisel or gouge and hammer to remove a portion of the bone. Other operators maintain that this procedure may cause concussion, and employ the surgical engine.

Osteoplastic Resection of the Skull.—Wagner devised the osteoplastic method of resection. It is employed for the removal of tumors and the Gasserian ganglion, and for exploration. A horseshoe incision is made through the scalp and periosteum, a groove corresponding to this incision is cut in the bone by special gouges or chisels. The bone is chiselled through, but is left attached to the scalp. The bone is then broken outward, the fracture taking place at the base of the bone-flap. After the operation the bone which is still adherent to the pericranium is restored to its proper place. Some surgeons use the surgical engine instead of the chisel, and others make trephine-openings and cut from within outward by means of the Gigli wire saw (Obalinski). The osteoplastic method of opening the skull is employed when a large opening is necessary, as when the operation is first of all for diagnosis. Krause, Keen, and others employ this plan in operating to remove the Gasserian ganglion.

Besides restoring a flap of bone into position, or replacing a button of bone, or strewing the dura with bone-fragments, other methods of closing the opening have been practised. For instance, heteroplasty with a decalcified bone-plate and heteroplasty with a celluloid plate or other foreign material.[1]

Trephining the Frontal Sinus.—This operation may be employed for inflammation of the lining membrane of the sinus or for empyema. Make a vertical incision in the middle of the forehead, starting one and one-half inches above the nasion and terminating at the root of the nose. The button of bone is removed and the opening is enlarged if necessary.

[1] See Bretano, in *Deutsche med. Woch.*, May 17, 1894.

The mucous membrane is incised, the opening into the nose is found and is dilated, and a drainage-tube is passed into the nose from the sinus, the upper end being left in the sinus. In some severe cases Jacobson advises us to curet the sinus, to disinfect it by the use of silver nitrate or chlorid of zinc, and to insufflate an "aseptic powder." In some cases resect the mucous membrane. Some surgeons prefer an osteoplastic resection to trephining.

Trephining the Mastoid (page 690).

Technique of Brain-operations (after Horsley and Keen).—Instruments as for fractured skull. In focal epilepsy a faradic battery is required. Always shave the scalp, and always antisepticize it. In localizations, mark out the fissure upon the scalp with an anilin pencil or with iodin. Have the patient semi-recumbent. Mark three points upon the bone with the center-pin of the trephine before incising the scalp (both ends of the Rolandic fissure and the point at which the trephine will be applied). Make a semilunar flap three inches in diameter, with the base below. Control bleeding in the flap by forceps pressure. The one and a half inch trephine should be employed, but if a smaller trephine is used, the opening must be enlarged with a rongeur. Before enlarging the opening, separate the dura from the bone by a dural separator. As a rule, open the dura and examine the brain. The dura is lifted by rat-toothed forceps and is opened with scissors along a line a quarter of an inch from the bone-edge, a broad pedicle of dura being left uncut. Hemorrhage is arrested by pressure and hot water, or by passing a curved needle threaded with catgut around any bleeding vessel. In some cases packing must be left in or forceps must be kept on. In packing, endeavor to use but one piece of gauze, so as to avoid leaving in a forgotten piece. Upon opening the dura cerebrospinal fluid flows out, the stream being increased with each expiration. Absence of pulsation of the brain points to tumor, and a livid color indicates subcortical growth. An old laceration is brownish. If the brain bulges through the opening, it means increased pressure (tumor, abscess, effusion into the ventricles, etc.). After opening the dura employ no antiseptics, especially when the surgeon intends using electricity to locate a center. Irrigate only with warm salt solution. In operating for tumor the dura is opened and in some cases the brain is incised. The tumor is turned out by the finger, or, if this is impossible, by the dry dissector, the scissors, the dull knife, or the sharp spoon. If the entire tumor cannot be removed, take away as

much as possible. The removal of a portion often retards the growth of the remainder, and the trephining, by lessening cerebral pressure, relieves the symptoms and prolongs life. After removing a tumor arrest distinct points of bleeding with the ligature alone or the ligature passed around the vessel by means of a needle. Pack the tumor-cavity with gauze and bring the end of the plug out of the wound. Stitch the dura with silk and suture the scalp with silkworm-gut. In electrifying the brain faradism is employed of a strength about sufficient to move the thenar muscles when applied to them. The current is applied to the motor area by the double electrode. A careful observer watches the muscular movements. If, for instance, the surgeon wishes to remove the thumb-center, he moves the electrode from point to point until he obtains thumb-movements. The region is sliced away bit by bit until the center which is responsible for the convulsive movements is removed. It will be found impossible to remove only the thumb-center. Adjacent centers are sure to be more or less damaged, and a certain amount of paralysis follows the operation. If we wish to tap the ventricles, Keen directs that the trephine-opening be one and one-fourth inches behind the external auditory meatus and the same distance above the base-line of Reid (Fig. 246, *a*). A grooved director or metal tube is passed into the brain in the direction of a point "two and one-half to three inches above the opposite meatus." The normal ventricle will be entered at a depth of two to two and one-fourth inches, but the dilated ventricle will be entered sooner (Keen). The moment of entry is marked by lessened resistance and a flow of cerebrospinal fluid. Drainage can be maintained by introducing a rubber tube. This operation has been employed in hydrocephalus. After an aseptic cerebral operation, as a rule, do not drain unless hemorrhage has been considerable. In many cases replace the bone, but not when the bone is diseased, is infected, or is very compact, or if it is desired to alter pressure. The dura is sutured by a continuous silk suture (Fig. 57); the scalp is sutured by interrupted silkworm-gut sutures (Fig. 56).

Operation for Mastoid Suppuration.—The instruments required in this operation are a scalpel, a gouge, a chisel, a mallet, curets, a probe, a dissector, dissecting- and hemostatic forceps, and needles. Provide a sand-bag to place under the neck. An incision is made one-quarter of an inch posterior to the auricle and down to the bone, and in the direction of the long axis of the mastoid. The bone is bared

and examined, especially at a point in the line of the incision which is on a level with the roof of the meatus (Fig. 246, *c*). The bone will usually be found softened. Gouge it away and thus open the mastoid antrum. This bone-opening is within the limits of Macewen's suprameatal triangle, a space bounded by the posterior root of the zygoma, the posterior bony wall of the meatus, and an imaginary line joining the two.

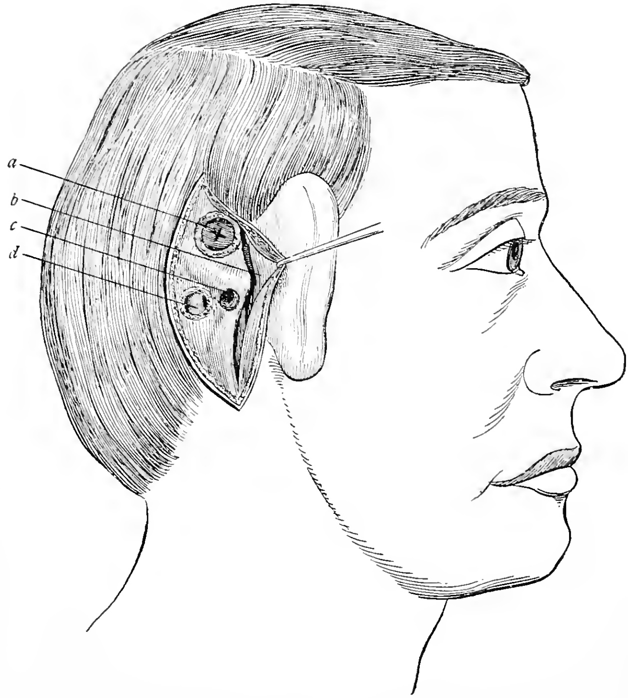


FIG. 246.—Opening the mastoid antrum and the lateral sinus; exposure of the temporo-sphenoidal lobe and puncture of the descending horn of the lateral ventricle: *a*, temporo-sphenoidal lobe (descending cornu of lateral ventricle is 1 cm. deeper); *b*, inner surface of periosteum: *c*, mastoid antrum; *d*, lateral sinus (Kocher).

If the mastoid is opened in this triangle, the antrum is entered directly and there is no chance of wounding the lateral sinus. If, in the adult, pus is not found on opening the mastoid antrum, gouge downward and backward, but with great care, so as to avoid the lateral sinus. If there be any possibility of the existence of pus in the groove of the sinus, the sinus should be unhesitatingly exposed. After evacuating the pus scrape the cavities with the curet, enlarge the opening between the mastoid and the middle ear with the

gouge, turn the head toward the side operated upon, and irrigate the mastoid with corrosive-sublimate solution (1 : 2000); dust in iodoform, pack with iodoform gauze for a few days, and then introduce a silver drainage-tube. Treat the causative ear disease. A. Marmaduke Sheild and Macewen operate on inveterate cases of mastoid disease as follows: a thick flap is raised behind the auricle, the flap including the orifice of any sinus and being "left attached by its stalk." The auricle is "detached forward and the soft parts over the mastoid are turned backward by horizontal incision." The "lining membrane of the canal is separated from the bone." The mastoid is opened and dead bone and caseous matter are removed, overhanging edges are chiselled down, and the posterior bony wall is gouged away. The skin-flap is pushed into the cavity and is held in place with pads of gauze. The margins of the flap may be sutured, but this is not necessary. Macewen calls this procedure "papering" the cavity with skin.[1]

If mastoid suppuration has established *abscess in the temporosphenoidal* lobe, trephine one and a quarter inches behind and one and a quarter inches above the middle of the external meatus (Barker's point, Fig. 246, *a*) and search for pus as directed on page 677. If *abscess of the cerebellum* exists, trephine below the line of the lateral sinus. "The position of the lateral sinus is indicated by a line running horizontally outward from the occipital protuberance to within about an inch of the external auditory meatus, and thence downward to the mastoid process" (Owen's *Manual of Anatomy*). If *infective sinus-thrombosis* exists, break into the lateral sinus (Fig. 246, *d*) through the mastoid opening and proceed as directed on page 679.

Linear Craniotomy.—Instruments as for any brain operation, plus, however, several kinds of rongeur forceps. Make a large flap. Trephine the skull a finger's breadth from the sagittal suture, and the same distance back of the coronal suture. Rongeur the bone away in a line parallel with the sagittal suture up to a point in front of the lambdoidal suture. Remove the pericranium which covered the bone excised. Insert the dural separator, or pass it along the margins. In some cases an additional portion of the bone is removed over the fissure of Rolando. Various suggestions have been made as to the direction and situation of bone-sections. Bleeding is arrested and the flap is closed without drainage.

[1] *Lancet*, Feb. 8, 1896.

Removal of Gasserian Ganglion (page 648).
Operation for Infective Sinus-thrombosis (page 679).

XXIV. SURGERY OF THE SPINE.

Congenital Deformities.—*Spina bifida*, or *hydrorrhachitis*, is a congenital cystic tumor due to vertebral deficiency, permitting protrusion of the contents of the spinal canal in the median line. The laminæ or spines of one vertebra or of several vertebræ may be deficient, most frequently in the lumbosacral region. *Meningocele* is a protrusion of dura mater and arachnoid, the sac containing cerebrospinal fluid, but no nerves and no cord-substance. *Meningomyelocele* (the commonest form) is a protrusion of dura mater and arachnoid, the sac containing cerebrospinal fluid, nerves, and cord-substance. The cord may spread upon the sac-wall or it may pass through the sac and re-enter the canal. *Syringomyelocele* is great distention of the central canal, the sac-wall being formed of the thinned cord. A spina bifida varies in size from that of a walnut to that of an infant's head; it grows rapidly during the early weeks of life; it is usually sessile, but may present where it joins the body a definite constriction, or even a pedicle; the base of the sac is covered with healthy skin, and the fundus is covered only by thin epidermis or by the spinal membranes themselves. Pressure upon the tumor is found to diminish its size and to increase the tension of the anterior fontanel, and possibly to cause convulsions or stupor. The cyst is transculent, and the margins of the bony aperture are distinct. Crying, coughing, or pressure upon the anterior fontanel makes the tumor more tense. Spina bifida is apt to be associated with club-foot, with hydrocephalus, and with rectal or vesical paralysis, Spina bifida usually causes death. A few meningoceles and a very few meningomyeloceles undergo spontaneous cure by the shrinking of the sac. Syringomyelocele is invariably fatal. The cause of death may be rupture of the sac or marasmus.

Treatment.—Very small protrusions which grow slowly and are covered with sound skin may be treated by the use of a compress and bandage, by an elastic bandage, or by applications of contractile collodion. It was formerly regarded as proper to tap and drain the sac. Injection was used by many. The sac being cleaned, the child was placed on its side and a little chloroform was given. A fine trocar was plunged obliquely in at the side through sound skin,

little or no fluid being drawn off, and ʒj of Morton's fluid injected (iodin, gr. x; iodid of potassium, gr. xxx; glycerin, ℥j). The trocar was withdrawn and the puncture was sealed with a bit of gauze and iodoform collodion. The child was put to bed. If injection proved successful, the sac was found to shrink; if the injection failed, it was the custom to repeat it at intervals of from seven to ten days (Jacobson, White). Surgeons now prefer excision of the sac. Bayer treats it as he would a hernia. Robson in some cases excises the entire sac.

Tumors of the Spine.—Among congenital tumors are lipomata and cysts (dermoid, congenital, sacral, and fetal). Tubercle, gumma, psammoma, and fibroma may arise from the cord or its membranes. Glioma is the most usual growth. Primary sarcoma is rare. Angeioma may occur. Primary carcinoma does not occur in this region. A tumor rarely produces obvious symptoms until it is as large as a hazel-nut.

Symptoms and Treatment.—Pain, stiffness of the back, areas of anesthesia, and progressively advancing motor paralysis are symptoms of spinal tumors. A tumor may produce the symptoms of compression-myelitis, locomotor ataxia, or myelitis. In glioma there are apt to be loss of ability to recognize variations of temperature (or even to distinguish between heat and cold), loss of the sense of pain, and paresis and atrophy of muscles. Contractures or paraplegia may arise. The location of the tumor can be inferred by a study of the territory of paralysis and the zone of sensory disturbance. The tumor is always situated somewhat above the upper limit of anesthesia. In many cases the diagnosis is impossible. Gradually increasing painful paraplegia with pain in the back, or with sensory paralysis after a time appearing and ascending from the feet toward the trunk, points to tumor as a cause. The reflexes are at first increased, but are finally lost from below upward. Spasms may develop, and lateral spinal curvature may arise. If curvature arises, the concavity of the curve will be on the side of the tumor. Growths outside the membranes produce particularly pain and spasm; growths within the membranes produce especially motor paralysis and anesthesia. If syphilis is suspected, give the patient a course of heroic doses of iodid of potassium, and administer mercury hypodermatically. In a focal lesion not due to dissemination of a known malignant growth perform the operation of laminectomy to permit of exploration and possibly of removal.

Acute osteomyelitis of the vertebræ is a rare disease; it may be associated with osteomyelitis of other bones, but may occur alone. Infections of the viscera not unusually accompany it. Any part of a vertebra may suffer from it. This condition arises from cold, over-exertion, or traumatism, and is more common in the young than in the old. The process may be superficial, or it may involve the bone deeply and widely. Suppuration always occurs; sequestra generally form; and phlebitis is a dangerous complication. Any region of the spine may be attacked, but the lumbar region is particularly liable to invasion. The situation of the abscess varies with the situation of the disease. If the vertebral bodies are diseased, the pus passes forward (retropharyngeal, mediastinal, psoas, or pelvic abscess). If the vertebral arches suffer, the pus passes backward (lumbar or dorsal abscess). The membranes of the cord, the cord itself, the nerves, and the vertebral articulations are frequently involved in the process. Staphylococci or streptococci may be grown from the pus.

Symptoms.—The general symptoms are those of osteomyelitis. The local symptoms depend on the seat of disease. If the posterior portion of the column is diseased, there is a hard swelling, which, in the neck, is in the middle line; in the dorsal and lumbar regions, in the middle or to the side; and in the sacral region, invariably to one side.

Rigidity always exists. If the vertebral bodies are affected, rigidity is noted, the spine is tender, and special symptoms arise dependent on the region affected (retropharyngeal abscess, etc.). Occasionally symptoms of meningomyelitis are noted. The constitutional symptoms of sepsis are marked. The condition is sudden in onset, and purulent collections diffuse widely and rapidly. These points enable the surgeon to make a diagnosis between osteomyelitis and Pott's disease. In osteomyelitis angular deformity very rarely arises, because the patient is obliged to be recumbent and because hyperostosis is taking place.

Treatment.—The patient is kept recumbent. His constitutional treatment is such as will combat sepsis (food, stimulants, etc.). A puriform area must be incised and disinfected. If bone denuded of periosteum is found, it is touched with a solution of chlorid of zinc or with the actual cautery. If a sequestrum exists, it is removed. A drainage-tube is inserted and dressings are applied (Müller, Makins, Abbot, and Chipault).

Spinal Curvatures.—There are four chief forms of

spinal curvature: (1) lateral curvature (the scoliosis of the older surgeons); (2) posterior curvature (the excurvation, gibbosity, or kyphosis of the older surgeons); (3) anterior curvature (the lordosis of the older surgeons); and (4) angular curvature (from spinal caries). The normal spine has four curves: the *cervical* curve, the convexity of which is forward; the *dorsal* curve, the convexity of which is backward; the *lumbar* curve, which is convex anteriorly; and the *pelvic* curve, which is concave anteriorly. The dorsal and the pelvic curves, which are primary, are due to the formation of the cavities of the chest and pelvis, and depend upon the shape of the bones (Treves). The cervical and lumbar curves, which are compensatory, depend upon the shape of the intervertebral disks, and only appear after birth when the erect position is assumed.

Lateral curvature (scoliosis) is a lateral deviation of the spinal column, often accompanied with rotation of the vertebræ and associated with increase or with diminution of the normal curves. Lateral curvature is predisposed to by weak muscles and ligaments, by the habitual assumption of strained and unnatural attitudes, by unequal length of the legs, and by paralysis of one leg. This distortion, which is commonest in girls, is apt to arise at the age of puberty (it is usually corrected in boys by outdoor exercise). The bones are soft and the muscles are weak, and this condition is often inherited. Rickets is very commonly associated with lateral curvature. Any condition of ill-health weakens the muscles; hence lateral curvature may arise after an acute sickness or in a person who outgrows his strength. An empyema with adhesions, by pulling on the chest-wall, may produce a curvature the concavity of which is toward the diseased side.

FIG. 247. — Lateral dorsal curvature to the right, and compensatory lumbar curve to the left.

The weak muscles cease to sustain the spinal column, and the ligaments stretch, relax, or lengthen. The commonest curve is toward the right in the dorsal region (because most people use the right hand more than the left). As soon as a dorsal curve to the right arises a compensatory lumbar curve (Fig. 247) takes place to the left, thus enabling the patient still to sit or to stand erect. In almost all cases the vertebræ soon rotate, the bodies turning to the convexity and the spines turning to the concavity of the curve; hence the transverse processes toward the convexity project. The ribs follow the

spinal rotation; the shoulder is elevated on the side of the convexity, and the hip on the same side is raised. The intervertebral disks are apt to flatten out on the concavity of the curve. In very rare instances lateral curvature results from caries of a half of one or of several vertebræ. In a spinal tumor lateral curvature may occur, the concavity of the bend being on the side of the growth.

Symptoms.—An ordinary case of spinal curvature from weak muscles arises gradually. Stooping is noticed, and after a time pain is complained of in the dorsal and lumbar regions, and weakness in the back is detected by the sufferer. The pain is made more severe by sitting long in one attitude. Anemia is manifest, and walking is awkward and ungraceful. When the shoes and clothing are removed, and the child stands with its back toward the surgeon and with the feet symmetrically together, the lower angle of the right scapula (in a dorsal curvature to the right) is unduly prominent and is elevated above the left; the normal prominence of the left iliac crest is lost; the right iliac crest is unduly distinct; on marking the spinous processes with an anilin pencil the curve becomes manifest; tenderness is often developed on pressing the spines; the normal dorsal anteroposterior curve is exaggerated; the abdomen is protuberant; the chest is flattened; the neck juts forward; and the breast on the same side as the concavity of the curve is more prominent and on a lower level than the other breast. Always observe if the anterior iliac spines are on a level or not, and always measure the length of the legs. The patient, with the knees extended, bends forward with the arms hanging loosely: the erector spinæ muscle between the iliac crest and the last rib is seen to be more prominent on the convexity of the lumbar curve than on its concavity (Bernard Roth), and the angles of the ribs on the side of the convexity of the dorsal curve are on a higher level than are those on its concavity. Have the child assume what it supposes to be an erect attitude, and let the surgeon correct this into the best possible position (Roth), and see how long the new position can voluntarily be maintained. A large percentage of these patients labor under pes planus. When there is no osseous deformity (that is, when the surgeon may, by manipulation and traction, correct the deformity), and when the spinal muscles are not paralyzed the prognosis is good for complete cure. Roth states that cases without osseous deformity can practically be cured in one month, but the treatment must be continued for one year to prevent

relapse.[1] In a case with moderate osseous deformity the patient can be improved vastly by three months' daily treatment (Roth). Even in severe cases of bony deformity the pain may be relieved and the deformity be modified.

Treatment.—If one leg is too short, let the patient wear a thick-soled shoe. No treatment for weak muscles has ever been devised so utterly irrational and absurd as the prevention of all movement; and neglect of all treatment for lateral curvature does less harm in the vast majority of cases than immobilizing the spinal muscles by braces and supports. The muscular nutrition in these cases is to be restored, as is muscular nutrition in any other region, by scientific gymnastics, electricity, the douche, salt baths, frictions, and massage. Bicycles with specially constructed seats are used with advantage in some cases. The mode of exercise to be used should be directed by some one skilled in orthopedics, and the instruction in the details must be thorough and persistent. Roth's advice is to so re-educate the muscular sense that a patient can again know whether she is or is not standing straight; to maintain an improved position in sitting and standing; to use such clothing as will not interfere with the assumption of a normal attitude; to enforce systematic training of the muscles of the spine and thorax; and to give attention to the general health. In some cases where, in spite of all attempts at correction, deformity increases, it may be necessary to immobilize in hope of obtaining ankylosis and preventing further deformity. In those rare lateral curvatures due to caries a supporting apparatus must, of course, be applied.

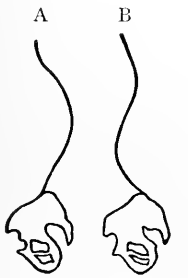


Fig. 248.—Kyphosis (A) and lordosis (B).

Anteroposterior curvature (not from spinal caries or from hip-point disease) is an increase of the normal anteroposterior curves. Increase of the dorsal curve is posterior curvature, kyphosis, or excurvation (Fig. 248, A); increase of the lumbar curve is anterior curvature, lordosis, or saddle-back (Fig. 248, B). Both lordosis and kyphosis are apt to be present. Scoliosis has nearly always some anteroposterior curvature associated with it. Lordosis is apt to be compensatory, to prevent the center of gravity going too far forward. Lordosis is found in pregnant women and in very fat men. In an old man kyphosis arises

[1] Heath's *Dictionary of Practical Surgery.*

from flattening out of the vertebral disks from pressure. Rheumatic gout may cause anteroposterior curvature. Anteroposterior curvature is often due to paralysis of the erector spinæ mass (from infantile paralysis.) Pseudohypertrophic paralysis causes lordosis.

Symptoms and Treatment.—The symptoms of anteroposterior curvature are as follows: the thorax is flattened or pigeon-breasted; the shoulder-blades are widely separated and the scapular angles project; the abdomen is protuberant; the patient complains of backache and soon tires. A recent kyphosis disappears when the patient lies upon his stomach. The facts that the erector spinæ muscles are soft, and that pain is absent on concussion transmitted from the heels, separate kyphosis from caries. Lordosis is unmistakable. When the spine is movable employ the same plan of *treatment* as that in lateral curvature, suiting the gymnastics to the deformity (Roth). In painful kyphosis with partial ankylosis endeavor to make the ankylosis complete in order to prevent pain, obtaining this result by applying a plaster jacket which laces up and letting the patient wear it for several years.

Angular curvature (Spinal Caries; Spondylitis; Pott's Disease) is usually due to tubercular caries of the vertebral bodies, and occurs particularly in children who are predisposed to tuberculosis, but it may arise at any age. Any portion of the spinal column may be attacked. The dorsolumbar region is most prone to suffer. The chief *cause* is tuberculosis, but syphilis, secondary cancer, and acute myelitis of the vertebræ are occasional causes. Blows or strains are often exciting causes. Angular curvature may develop after an exanthematous fever.

The cancellous tissue of the anterior portion of a vertebral body becomes primarily carious, or the inflammation begins in an intervertebral disk. (The changes of tubercular osteitis have previously been set forth.) The body of the vertebra and the vertebral disk are destroyed, and the process extends to adjacent vertebræ. The weight which rests upon the spinal column causes softened bone to crumble, compresses the diseased vertebræ and disks, and produces angular deformity (the anterior part of the spine formed by the vertebral bodies is shortened, the posterior part is not, and hence the spines project). In some cases the disease is spontaneously arrested by organization of inflammatory products, and ankylosis (fibrous or bony) in deformity is Nature's cure. In most cases, however, the dis-

ease spreads and caseous pus is formed, which, according to the route it takes, causes lumbar abscess, dorsal abscess, psoas abscess, or postpharyngeal abscess (page 136). In some cases the spinal cord is compressed, but in most cases it is not, and even when it is compressed paraplegia is rare and is usually temporary. Compression of the cord may be caused by the displaced vertebræ or by inflammatory material or caseous matter between the bone and dura mater, but is most often due to pachymeningitis. Caries of the cervical region constitutes a more dangerous disease than caries of either the dorsal or the lumbar region (dangerous pressure occurs more easily). Death may be caused by exhaustion, sepsis, hemorrhage, amyloid disease, pneumonia, peritonitis, pleuritis, tubercular dissemination, pressure upon the cord, or inflammation of the cord or its membranes.

Symptoms.—The first symptom of angular curvature is pain in the back, which is increased by motion, by pressure, and by vertebral jars. Neuralgic pains pass into distant parts (sciatica, intercostal neuralgia) and are often linked with muscular spasm. Pain may not appear until late in the progress of the case. A chronic bilateral pain in the trunk or extremities is suggestive of Pott's disease. "Chronic bilateral belly-aches in children are almost diagnostic" (Jordan Lloyd). The pain of dorsal caries can be relieved by lifting the shoulders; the pain of cervical caries by traction on the head. Cramp in the legs occurs in dorsal and in lumbar caries. The sufferer from Pott's disease, if a child, grows tired easily, his disposition alters, he becomes moody and irritable, and complains of vague pains in many places, is disposed to lean, rest, or lie down, and walks with the back rigid, which produces a peculiar gait. A painful spot is found by pressing upon the spines, and the same spot is painful on pressing the head downward or upon jarring the entire spine. Faradism to the back causes pain. Spasm of the erector spinæ mass is detected (Hilton, Golding-Bird). The presence of the knuckle due to bending the spine at an acute angle is a very important sign of the disease. In many cases angular deformity appears late, in some cases it does not appear at all. An angular deformity is detected sooner in those regions where the normal curves are posterior than where normal curves are anterior (Jordan Lloyd). The deformity appears early in the dorsal region, but late in the cervical and lumbar regions. In some rare cases lateral deformity occurs. Rigidity is an early sign of great impor-

tance. It is always present. Rigidity is manifest very early in cervical caries, tolerably early in lumbar caries, late in dorsal caries. Lloyd gives the following practical rules to enable us to detect rigidity.[1] In the cervical region: seat the patient in a chair and tell him to nod the head affirmatively. Stiffness in nodding points to occipito-atloid disease. Tell him to look far to the right and then far to the left. Stiffness of these motions suggests atlo-axoid disease. Tell him to place his shoulders against the back of the chair and carry his eyes back along the ceiling. Stiffness in this movement indicates disease below the second cervical vertebra. It is practically useless to examine the dorsal region of an adult for rigidity, but such an examination can be made in a child. Place the patient prone on an adult's lap, mark the tip of each spinous process with an anilin pencil, make the child stand up straight, and observe if any of the marks fail to come nearer together, If it is seen that two or more marks do not approach each other, there is rigidity which prevents approximation. To test for rigidity in the lumbar region lay the naked patient prone upon a couch. Grasp the patient's ankles and raise the pelvis from the couch. If the lumbar spine is flexible, the pelvis can be lifted without raising the chest from the bed, and the maneuver deepens the hollow of the loin. If the lumbar spine is stiff, the maneuver lifts the trunk and produces no alteration in vertical outline of the lumbar spines. If a child with Pott's disease is asked to pick up something from the ground, because of rigidity or pain on movement he will not bend the back, but will bend the knees or get upon the knees. Paralysis may exist, and it is due to pachymeningitis more often than to pressure from bone. Cervical caries causes dyspnea and torticollis, the head requiring support with the hands. Dysphagia indicates abscess. In adults the first signs of Pott's disease to attract attention are headache, backache, neuralgia, girdle-pain, cramp, or even paralysis. In abscess due to caries of the dorsolumbar vertebræ the pus usually enters the psoas muscle and passes out of the pelvis below the junction of the middle and outer thirds of Poupart's ligament. It may point here or may pass to the inner aspect of the thigh and point a little below the spot where a femoral hernia is met with if it exists. In sacral caries there is no deformity and frequently no pain. The diagnosis becomes apparent when bilateral abscess is detected in the buttocks or groins (Jordan Lloyd). If an abscess due to spinal caries opens sponta-

[1] *Birmingham Med. Review*, April, 1897.

neously, healing will not occur, but mixed infection takes place and death, as a rule, soon follows.

Treatment of Caries of the Spine.—When recent caries of the spine is active and affects a child, when it is accompanied with pain and fever, and when paralysis threatens, insist upon perfect rest. Place the child supine on a hard mattress, and, if possible, take it, while in a rolling bed, out of doors daily. Leeches, blisters, or the hot iron over the area of pain may do good. When the activity of the process abates apply a fixation apparatus. In diseases at or near the vertebro-occipital articulation, as long as dyspnea persists, keep the patient supine with a small hard pillow under the nape of the neck (Hilton) and a sand-bag on each side of the head

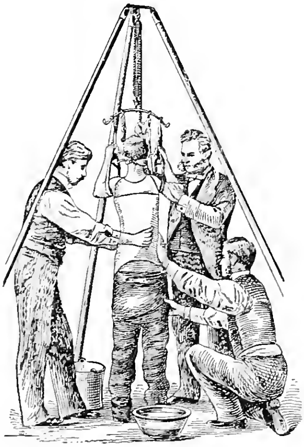


Fig. 249.—Plaster-of-Paris jacket (Sayre).

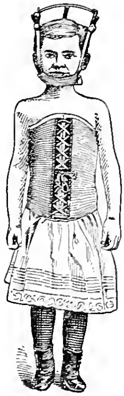


Fig. 250.—Plaster-of-Paris jacket and jury-mast applied (Sayre).

and neck. After several months mechanical support can be given by Furneaux Jordan's method. Jordan applies his support as follows: the patient lies on a flat hard table, his arms are raised above his head, and traction is made upon the head by means of a pulley and a weight. Cotton pads are placed over the ears, the back of the neck, and the clavicles, and are held in place by a flannel bandage applied as a figure-of-8 of the head, neck, and chest. The flannel bandage is overlaid with plaster-of-Paris bandages.[1] In disease of the cervical region below the axis use Sayre's jury-mast (Fig. 250). This appliance relieves the spine from the weight of the head and acts admirably. In most cases

[1] See *Children's Deformities*, by Walter Pye.

of dorsal and lumbar caries some fixation apparatus must be employed. The best of all fixation apparatus is Sayre's plaster-of-Paris jacket applied while the patient is suspended (Fig. 249). The Sayre apparatus applied in this manner is used for the treatment of caries of the lumbar region and the lower half of the dorsal region. When all subjective signs cease substitute for Sayre's jacket a felt jacket which laces (Golding-Bird). Caries of the upper half of the dorsal region is often treated by a Sayre's jury-mast (Fig. 250); but if the jury-mast fails, it may be necessary to place the patient horizontally in "an open cuirass, fitted to the back from occiput to sacrum, and combined with pulley extension to the head and pelvis."[1]

Spinal abscesses are treated as indicated on page 593. Treves opens the abscess in the loin, employing a vertical incision; introduces a finger, and examines the anterior surface of the vertebræ (if the patient be young and slender and if the disease affects the dorsal or lumbar region); irrigates with gallons of warm corrosive-sublimate solution (1 : 5000); scrapes the wall of the abscess with the finger or rubs it with a sponge; irrigates again; scrapes again, and so on until the wall is cleared of débris; wipes the abscess dry, and sutures without drainage. The patient remains recumbent for months. It may be necessary to repeat the operation. If mixed infection occurs, drainage-tubes must be inserted. Treves formerly removed the carious bone, but many surgeons do not approve of removing bone. Halsted opens the abscess-cavity widely, removes as much of the wall as possible, and packs with iodoform gauze. Barker opens the abscess at its lower portion and inserts an irrigating curet. This instrument is a hollow gouge through which hot water flows. He scrapes and irrigates the abscess-wall with this instrument. When the water runs clear he withdraws the instrument, injects three ounces of iodoform emulsion, and sutures the wound. Chipault, Calot, and others have advocated forcible correction of the deformity in Pott's disease without abscess. Forcible correction is only used, if used at all, in angular deformity of the middle and lower part of the dorsal region. It is not used in the cervical, upper dorsal, or lumbar region. Before it is used a skiagraph should be taken, to show if bony ankylosis exists or if there is an abscess. If there is an abscess, it must be treated surgically, and must heal before forcible correction is attempted. If bony ankylosis exists, it must not be broken

[1] Jordan Lloyd, in *Birmingham Medical Review*, April, 1897.

down. Only recent cases are suited for this treatment, and only cases in which very few vertebræ are involved (Gabaert). The operation is unjustifiable if any organs are tubercular, and if a patient is in very poor health. It is particularly indicated when the deformity interferes with respiration or digestion, or when there is paraplegia. The operation does not injure the cord or its membranes. The operation is not entirely safe, and a number of deaths have been reported. Chloroform must not be given, as it seems to possess special dangers in this condition. Gabaert[1] points out certain disasters which may follow forcible correction. They are: death during anesthesia; rupture of an abscess; subsequent paralysis of the legs and bladder; disseminated tuberculosis; and shock with convulsions and death. Forcible correction can be carried out as follows: the patient is anesthetized with ether, and is placed face down; one assistant holds the feet, another the head, another supports the abdomen, and another the pelvis. While strong traction is made on the head and feet, the surgeon makes forcible pressure on the projection. After the correction of the deformity a plaster-of-Paris support is applied so as to include the neck, trunk, and pelvis, the gibbosity being left exposed in order to avoid ulceration. A plaster-of-Paris support is used for at least six months. After forcible correction a large gap exists, and this does not fill up with bone, but with dense fibrous tissue, and in some cases the spines and laminæ ankylose. When the support is first removed, there is usually a reappearance of the deformity to some degree. In some cases Calot resects the spines and laminæ of the diseased vertebræ, and performs osteotomy of the ankylosed vertebral bodies.[2]

If paraplegia is due to disease of the middorsal region, forcible correction should be attempted. Some surgeons have warmly advocated laminectomy in spinal caries paraplegia. This operation is rarely necessary, but in some few cases is imperatively demanded. Many cases recover from paraplegia without operation—operation has a very heavy mortality; many are not benefited at all by it, but in some cases it has certainly saved life.

Laminectomy should not be undertaken until treatment by rest and fixation has been applied for at least one year (Willard).

Laminectomy may be necessary in cervical caries to prevent asphyxia. The operation enables the surgeon to re-

[1] *Ann. de la Soc. Belge*, July 15, 1898.

[2] F. Calot, in *Archiv. Prov. de Chirurgie*, Feb., 1897.

move masses of inflammatory material which make pressure on the cord. The dura should not be opened unless there is evidently trouble beneath it, in which case it is incised and any tubercular area removed, the dura being subsequently sutured. Ménard removes the transverse processes of the diseased vertebræ and the heads and necks of the associated ribs in order to give the surgeon access to the diseased vertebral bodies.

During the course of caries of the spine have the patient eat fat-forming and nutritious food, try to get him out often into the fresh air, and administer tonics and antitubercular drugs. Sea-air is very beneficial. When all active disease ceases, and only angular curvature remains, use an apparatus to combine extension with mechanical support, the plaster jacket being generally employed.

Spondylitis Deformans.—This is the name usually applied to osteo-arthritis of the spine. In this disease osteophytic formation takes place at the vertebral borders, and the vertebræ become ankylosed. The vertebral bodies as a rule are most affected by the disease, but any portion of a vertebra may be attacked, and often the heads of the ribs are anchored to the spine by bone.

The disease may begin in infancy, childhood, youth, adult life, or old age.

Symptoms.—There are decided and persistent pain and also tenderness of the spine, and occasionally evidence of pressure on the nerve-roots. Early in the case deformity is apt to occur, because at this period there is inflammatory softening.[1] The deformity is not angular, but is usually a total kyphosis, the column being bent forward from above and made into a single curve. Lateral curvature may occur.

Treatment.—Cure is impossible, but amelioration can be obtained.

The local and constitutional treatment is as for osteoarthritis in any region. If curvature begins, a mechanical support must be applied.

Injuries of spinal ligaments and muscles, which may complicate more serious injuries or may exist alone, are caused by wrenches, twists, and violent muscular efforts (as in lifting). Railway accidents may be responsible for these sprains and strains.

Symptoms.—Injuries of the back, even without cord-injury, are frequently linked with very deceptive nervous symptoms. Symptoms are often severe, but are usually

[1] J. Jackson Clarke's book on *Orthopedic Surgery*.

temporary. In some few cases the symptoms are persistent. Secondary disease of the cord is extremely rare. Any region may be affected, but the lumbar is most usually injured, and the entire spine may suffer. The three marked symptoms are pain, tenderness, and stiffness of the back. At the time of injury, and for a time after, there is often marked shock, and hysterical excitement is occasionally observed. The cardinal symptoms may arise very soon, but may not become severe for a day or two. The pain is not acute when at rest, but becomes acute on movement.[1] The pain is felt in the back, and sometimes darts into the extremities. The muscles of the back are rigid, the spasm being due to pain. The patient is very careful not to twist or bend the spine, because to do so increases pain. In a one-sided injury the rigidity is unilateral, and this symptom cannot be simulated. Often, but by no means always, the region of the back is swollen and the skin is discolored. The tenderness is not of the skin, but of the muscles. Firm pressure on a spot of real tenderness causes rapid pulse (Mannkopff). The vertebral spines are regular and are not mobile. There is no distant paralysis or hyperesthesia unless the cord is damaged (though in some rare cases the bladder and the rectum are paralyzed when no cord-lesion can be detected, and hyperesthesia may exist over the spines). Moullin tells us that the extremities feel weak because they are deprived of proper support on account of the immobility of the muscles of the back. For the same reason the action of the abdominal muscles is interfered with, and the power of micturition and of defecation is impaired (there are constipation and difficulty in emptying the bladder).

The **treatment** of recent injuries comprises rest; the application of an ice-bag and leeching over the painful area. After a day or two hot fomentations, tincture of iodin, and inunctions of ichthyol and lanolin are used; and, later still, massage, douches, and frictions with a stimulating liniment are employed. Phenacetin helps to relieve pain, though in some cases opium is necessary. The injury is called "railway spine" when it is caused by a railway accident.

After the *immediate* effects of the accident subside traumatic neurasthenia is apt to arise. In this condition the patient grows tired easily and complains of pains and aches in the back and loins, interfering with or preventing work; paresthesia and numbness exist in the extremities; in many

[1] Moullin on *Sprains*.

cases sexual intercourse is impossible because of premature ejaculation or of incapacity for erection; there are dyspepsia, eye-strain, insomnia, loss of memory, rapid and irregular pulse, cardiac palpitation, and mental depression or confusion. The reflexes are usually exaggerated, but they can be exhausted more easily than can the exaggerated reflexes of organic cord disease (because of irritable weakness). Some rigidity and tenderness exist in the back, and the skin over this region is often hyperesthetic. Attacks of retention of urine may occur. Hypochondria is not unusual.

Treatment of Traumatic Neurasthenia.—Employ rest, tonics, massage, douches, and frictions to the back. Secure sleep, and endeavor to bring about a gain in weight. If sexual incapacity or seminal emissions worry the patient, dilate the urethra with steel bougies.

Traumatic hysteria develops only in those predisposed by a neuropathic hereditary tendency; traumatic neurasthenia may arise in anybody. In the first disease the accident is only the *exciting* cause; in the second disorder it is *the* cause. Many cases of so-called "railway spine" are really examples of traumatic hysteria. Traumatic hysteria and neurasthenia may be associated. Neurasthenia is a condition of exhaustion associated with a number of chronic disorders; it forms a foundation on which hysteria is apt to build its structure. The structure of hysteria is made up of morbid impressionability, hyperesthesia of centers, lowered self-control, and sensitiveness of the peripheral nervous system. The accident plays a double part in producing traumatic hysteria: first, by its effect on the mind (psychical traumatism); second, by its effect on the body, which anchors the attention to one point. An area of pain or stiffness often serves as an autosuggestion which undergoes morbid magnification when viewed through the distorting medium of hysteria. Erichsen taught that the symptoms of what he named "railway spine" arose from inflammation of the cord and its membranes, a view now abandoned. A blow given to a hysterical person causes a feeling of numbness, and thus negative sensation from local shock may establish the idea of paralysis, or the traumatism, acting as a suggestion, may inhibit motor representations and destroy the normal ideas of motion and feeling (Charcot and Pitre). Terror always causes a feeling of loss of power in the legs, and the terror of the accident may thus develop the idea of paraplegia. The site of a traumatism may localize symptoms; for instance, a blow upon the eye may cause amaurosis or blepharospasm. It is im-

portant to remember Charcot's saying that a hysteria long latent and unrecognized may be awakened into obvious activity by a blow or an accident. Pitre shows the same to be true of epilepsy. A not unusual lesion is hysterical traumatic monoplegia, not coming on at once after the accident, but usually some days afterward, and presenting flaccid muscles, the electrical reactions and reflexes remaining normal, but the muscular sense being lost (Pitre). The muscles usually waste. The skin of the paralyzed limb is anesthetic or analgesic. There may be anesthesia limited to a limb, hemianesthesia, or general anesthesia.[1] Hysterical paralysis is usually associated with the permanent stigmata of hysteria—concentric contraction of the visual field, pharyngeal anesthesia, convulsive seizure, and hysterogenic zones (Clarke and Pitre). The permanent stigmata may be latent. Hysterical phenomena lack regularity of evolution, and they may be produced, altered, or abolished by mental influences or by physical forces which produce no effect on organic disease. In most hysterical conditions the general health is not profoundly impaired.[2]

Treatment.—By moral means chiefly. Gain the confidence of the patient. In many cases separation from family and friends is necessary and isolation is desirable. The Weir Mitchell rest-cure is the best plan of treatment, and all its details should be carried out faithfully.

Malingering.—Persons often pretend to suffer from maladies as a result of accident which diseases do not exist in them. Some get well upon the rendering of a favorable verdict by a jury. In any case always examine carefully, so as to be able to exclude malingering. Note the patient's behavior and motions when his attention is diverted from his disease. *Meningomyelitis* can be excluded if there be no spasm, paralysis, hyperesthesia, paresthesia, or anesthesia at a distance (A. Pearce Gould). If pain has lasted for months, if pressure downward upon the head or shoulders does not increase pain, if the vertebræ are movable, and there is no angular displacement, exclude *caries.* Gould states that when there are wasted muscles, when moderate spine-movement is painless, but effort in bringing the body erect causes pain in the erector spinæ region, the trouble is a strain of the erector spinæ muscle. If the muscle is not wasted, and the pain is in bending forward rather than in straightening up, the vertebral ligaments are the seat of trouble. Unilateral

[1] J. Mitchell Clarke, in *Brain.*
[2] Read the works of Thorburn and Pitre.

spasm cannot be simulated. The administration of ether may dispose of a pretended paralysis, the patient moving the suspected extremity while drunk from the anesthetic.

Concussion of the Spinal Cord.—This term has no definite pathological meaning. It is probable that the condition is one of laceration of capillaries and of cord-substance.

The **symptoms** are shock, intense pallor, nausea, often vomiting, and sometimes syncope. With this condition special symptoms may be linked—as temporary paralysis, a girdle-sensation, numbness and loss of power in the limbs, hiccough, torticollis, coarse tremors, pains in the back and limbs, areas of anesthesia and analgesia—depending on the portion of cord lacerated.

Treatment.—The treatment in concussion of the spinal cord is the same as that for sprains. Traumatic neurasthenia and hysteria or organic cord-disease may follow this injury.

Contusion of the spinal cord may arise from a blow or a sprain, but it is usually due to extreme flexion of the spine. It causes hemorrhage into the gray matter of the cord (hematomyelia). The symptoms are motor and sensory palsy and diminished reflexes. Some cases recover, but others end in myelitis.

Wounds of the spinal cord are rare, and are usually fatal. Wounds above the origin of the phrenic nerves cause almost instant death. Gunshot-wounds are the most usual form, the cord being damaged by the bullet and by bone-fragments. A knife is sometimes thrust in between the occiput and atlas.

Compression of the spinal cord may be due to blood or to inflammatory exudate. *Compression from blood* may be due to *extramedullary* hemorrhage or to *intramedullary* hemorrhage. *Extramedullary* hemorrhage causes sudden pain in the back, the pain radiating from compressed nerve-roots; hyperesthesia and paresthesia in the area of the radiated pain; spasm of vertebral muscles supplied by the compressed nerves, sometimes of muscles whose nervous supply is below the lesion; tremors; convulsions; retention of urine; paralytic symptoms following the signs of irritation, but no absolute paralysis (Mills). A girdle-sensation is usual. *Intramedullary* hemorrhage causes pain, a girdle-sensation, abolition of reflexes, and paralysis. Spasms, rigidity, and paralysis come on early. Bed-sores may form, and retention of urine and incontinence of feces may be observed. Paralysis from hemorrhage is gradually progressive from below upward (crawling paralysis).

Treatment.—If paralysis from spinal-cord bleeding extends rapidly, and life is endangered through the probable involvement of a vital center, perform a laminectomy, remove the clot, and arrest the hemorrhage. It is wise to always open the dura and inspect the cord. Extramedullary hemorrhage may be arrested by sutures or by packing. Intramedullary hemorrhage may be arrested by a suture-ligature or by packing. If an extramedullary clot is extensive, it is proper to make a second laminectomy near the lower end of the spinal column in order to permit the surgeon to thoroughly wash it out. The dura must be sutured and drainage is to be employed. If there is paraplegia, complete anesthesia of the paralyzed parts and entire abolition of the deep reflexes, operation is useless because the cord is destroyed. In some cases with persistent paraplegia the operation should be undertaken. If operation is not undertaken, have the patient to lie upon his side and give morphin hypodermatically. If hemorrhage continues in the cord and if the patient be plethoric, perform venesection. Some surgeons advise hypodermatic injections of ergotin. To promote absorption of the clot and exudate give a combination of carbonate and acetate of ammonium, order pilocarpin, and employ spinal galvanism and hot douches (Bartholow).

Fractures and dislocations of the spine are very rare. The spinal regions most liable to injury are the atlo-axial, the cervicodorsal, and the dorsolumbar (Treves). A vertebra may be fractured alone, but dislocation without fracture, except in the upper cervical region, very rarely occurs. These two lesions, dislocation and fracture, are so often associated that the term *fracture-dislocation* is used by many surgeons to include them both. The **causes** of fracture and dislocation are direct force (rarely) and indirect violence (commonly). Fracture-dislocation from direct force may occur at any part of the column, and in this accident the posterior vertebral segments are driven together, and the cord, as a rule, escapes injury. Fracture-dislocations from indirect force most commonly happen in the cervical and dorsal regions. In the cervical region reduction can usually be secured, but in the lumbar region reduction is impossible. In fractures from indirect force the cord generally suffers.

Symptoms.—In fracture-dislocation much displacement is rare, but some is almost always recognizable (irregularity of the spines or angular deformity). There are pain (which is increased on motion), tenderness, ecchymosis, and

motor and sensory paralyses. Priapism, cystitis, and retention of urine often occur. Horsley has pointed out that in many cases paralysis passes away only to subsequently recur, the recurrence being due to edema of the cord. In some cases of spinal injury there is temporary paralysis due to shock. Persistent paralysis may be due to laceration of the cord or compression of the cord by bone, blood-clot, or products of inflammation. In total division of the cord the deep reflexes are abolished, anesthesia exists, and there is motor and vasomotor paralysis. The extent of paralysis depends on the seat of the cord-injury. The prognosis depends on the amount of damage done to the cord. Fracture-dislocations in the cervical region produce obvious deformity, stiffness of the neck, and irregularity of the spines, and a displaced vertebra may occasionally be detected by a finger in the pharynx. Crepitus can rarely be detected unless a spinous process is fractured. The Röntgen rays aid diagnosis.

Treatment of Fracture-dislocations.—When dislocation of the body of a vertebra obviously exists, the surgeon may attempt reduction by extension and rotation (White). The maneuver is very dangerous in the cervical region, and, as deaths have happened, some eminent surgeons advise against reduction when the injury affects that region. In fracture-dislocation the traditional plan is to straighten the spine, gently if possible, and to put the patient upon his back upon a water-bed or upon air-cushions. In fractures in the cervical region support the head and neck with sandbags. Empty the bladder every six hours with a soft catheter, which is kept strictly aseptic. Take every precaution to prevent bed-sores. Some surgeons advocate reduction of the deformity by extension and counter-extension, and the application of a firmly-fitting but removable jacket with the suspension collar (as used in Pott's disease). If this plan is employed, the head of the bed is raised and the collar is fastened to it. Every day extension is made gently from the shoulders in dorsolumbar fracture, and from the chin and occiput in cervical fractures. Extension may be maintained permanently until cure. White says laminectomy should be performed for fracture or for dislocation when there is obvious depression of the vertebral arches; in all cases of pressure upon the cauda equina; when there are characteristic symptoms of spinal hemorrhage; and in some cases where rapid degeneration becomes manifest. Surgeons, as a rule, agree that operation

will be useless when there are motor paralysis, complete persistent anesthesia, and entire loss of deep reflexes, because these symptoms indicate that total division of the cord has taken place. It is useless to operate for fracture-dislocation of the atlas or axis. In ordinary cases of fracture-dislocation below the axis in which the cord is not completely divided treat by extension for six or eight weeks, and then operate if the case is not improving. In hemorrhagic cases, or cases with marked depression of the arches, operate early. If signs of degeneration begin within six or eight weeks, operate at once. "In compound fractures, in injuries of the laminæ and spinous processes without a complete crush of the cord, when symptoms are due to hemorrhage, when pachymeningitis arises, if the cauda equina is compressed, operate" (Thorburn).

Operations on the Spine.—**Operations for Spina Bifida.**—Mayo Robson maintains[1] that operation is not demanded when the sac is of small size and is well protected by sound integument; that operation is improper when a large portion of the column is fissured, or when paraplegia or hydrocephalus exists; that operation is advisable only in meningocele, in cases in which the integument is thin and translucent, in cases in which the cord is flattened out, or the nerves are fused. Robson has closed the osseous defect by transplanting periosteum.

Instruments Required.—Scalpels, dissecting- and hemostatic forceps, scissors, rongeur forceps, dural separator, Hagedorn needles and needle-holder, silk, silkworm-gut or catgut.

Operation.—Surround the sac by elliptical incisions. Find the neck of the sac, and if it contains no visible nerves ligate it and cut off the protrusion. Push the stump into the canal. Freshen the bone-margins and spring a piece of celluloid beneath them to close the gap (Park). Suture over the stump with small sutures of catgut.[2]

Treves's Operation for Vertebral Caries (page 593).

Laminectomy.—The instruments required in laminectomy are dissecting-, rat-toothed, and hemostatic forceps; scalpels; bone-cutting forceps; rongeur forceps; a dry dissector; a periosteum-elevator; sequestrum-forceps; small scissors, straight and curved on the flat; a chisel and mallet; retractors; blunt hooks; a probe; tenaculum-forceps; a spoon-

[1] *Annals of Surgery*, vol. xxii., No. 1.

[2] A full consideration of the various plans of operating will be found in an article by Marcy, in *Annals of Surgery*, March, 1895.

curet; a sand-pillow; fine needles, curved and straight, large needles, and a needle-holder.

In the *operation* of laminectomy the patient lies prone and a sand-pillow is placed under the lower ribs. Make a vertical incision over and down to the vertebral spines, the middle of the incision corresponding to the seat of injury or disease. The sides of the spinous processes and the laminæ are cleared. The periosteum is incised in the angle between the laminæ and spines, and is lifted away from the arch. The spinous processes are cut off close to their bases by means of rongeur forceps, the laminæ are removed on each side with the rongeur, and the dura is exposed. In some cases of fracture fragments will be found on exposing the vertebra, or a blood-clot will be seen between the dura and the bone; in other cases the dura must be opened with scissors vertically in the middle line while it is grasped with rat-toothed forceps. After reaching and removing the compressing cause, or after failing to find or remove it, close the dura with catgut, drain the length of the wound with a tube, stitch the superficial parts with silkworm-gut, and dress antiseptically.

Puncture of the spinal meninges, or **lumbar puncture,** was devised by Quincke, and has been carefully tested by many surgeons (Fürbringer, Naunyn, and others). It is employed as a means of diminishing cerebral pressure in hydrocephalus, cerebral tumor, uremia, and tubercular meningitis. It has proved of little therapeutic value. In some cases the examination of the fluid has been of diagnostic value. Stadelmann has reported 37 cases in which tubercle bacilli were found in the fluid.[1] Turbidity of the fluid indicates the existence of meningitis. The back is sterilized; the patient may lie prone, with a pillow under the belly, or may sit in a chair, with the body bent forward; no anesthetic is required. A Pravaz syringe is employed, and the point is inserted at the under surface of a spinous process. In some cases but a few drops of fluid will be obtained, in other cases several ounces may be removed. See [illegible]

XXV. SURGERY OF THE RESPIRATORY ORGANS.

1. Diseases and Injuries of the Nose and Antrum.

Foreign bodies in the nose are usually introduced through the anterior nares, but in rare instances they enter by way of the posterior nares. Small particles are often

[1] *Berliner klinische Wochenschrift,* July 8, 1895.

expelled spontaneously; larger pieces collect mucus and epithelium and become fixed. Some materials swell after lodgement.

Treatment.—In many cases anesthesia is required. Illuminate the nostril, and, if the foreign body can be seen, insert a hook back of it and effect its removal by means of forceps. Some foreign bodies require to be pushed back into the nasopharynx. Occasionally expulsion may be effected by inserting a rubber tube into the unblocked nostril and telling the patient to blow forcibly through the tube. In serious cases a specialist should be summoned to remove a portion of the turbinated bone or to perform whatever operation he thinks best.

Inflammation and Abscess of the Antrum of Highmore (Maxillary Antrum).—The source of this disease may be inflammation of the nose or periostitis around the roots of the teeth. In some cases the opening into the nose is patent; in other cases it is partly or completely blocked. Caries and necrosis may arise. The **symptoms** are pain, edematous swelling of the face, and thinning of the bone so that it may crepitate under pressure. When pus has formed, if the antral opening is patent, certain positions of the head will cause a purulent flow from the nose, and if a speculum is inserted pus may be seen as it flows into the nose. The opening of the maxillary antrum into the nasal channel is at the summit of the antrum; hence the antrum drains when the head is inverted. The ethmoidal cells and frontal sinus drain best when the patient is upright. Wipe the interior of the nose and place the patient with his head between his knees. If the nostril fills with pus, it comes from the antrum (Cobb). In severe cases the jaw expands, the eye protrudes, and great tenderness of the alveolus exists. Percussion exhibits a dull note. In making a diagnosis it is well to take the patient into a dark room, insert an electric light into the mouth and note the diminution of light-transmission on the diseased side as contrasted with the sound side. Transillumination may be easily practised by the use of a cautery electrode, protected by a small glass vial. Any cautery battery may be employed (plan suggested by Ohls). Exploratory puncture will settle a doubtful diagnosis. This may be by way of the lower meatus, the canine fossa, or the alveolar process.[1]

Treatment.—Before pus forms order the use of hot fomentations and remove any diseased teeth. When pus has formed evacuate it at once. Before performing a severe operation try

[1] Cobb, in *Boston Med. and Surg. Jour.*, May 7, 1896.

the effect of opening into the antrum from the nose, by means of Krause's trocar, followed by insufflation of iodoform. If this procedure fails, other means may be employed. If the disease arises from a carious tooth, pull the tooth and push a trocar through its socket into the antrum. If the teeth are sound, bore a hole with a large gimlet or with a bone-drill above the root of the second bicuspid tooth and one inch above the edge of the gum. A counter-opening should be made into the inferior nasal meatus. A drainage-tube is pulled from the first opening into the nose and is allowed to protrude from the nostril. Irrigate daily with peroxid of hydrogen. In three or four days discontinue through-and-through drainage, but prevent the first opening closing until the discharge ceases to be purulent. In severe cases make a free incision through the canine fossa by means of a chisel.

Distention and Abscess of the Frontal Sinus.—The usual cause is an injury which may long antedate the symptoms. This injury causes or leads to blocking of the infundibulum; secretion accumulates and distends the sinus; and in some cases pus forms. In many cases the fluid slowly accumulates, and it requires years to produce marked symptoms. In other cases infection takes place, and the symptoms are positive and violent. If the outlet into the nose is not permanently blocked, the fluid may discharge itself from time to time. In the chronic cases there is rarely much pain. The chief sign is a swelling of the inner or upper part of the orbit, which swelling progressively increases in size and displaces the eye. If at any time acute symptoms supervene, there will be pulsatile pain, discoloration, and tenderness.

Treatment.—In some cases it is possible to pass a trocar upward from the nose into the sinus, and so drain and irrigate. In most cases an incision should be made through the soft parts, and the sinus opened by a trephine or chisel. After the sinus has been opened it must be curetted, the opening into the meatus should be restored and enlarged, and a drainage-tube is to be passed from the forehead incision into the nostril. Some surgeons open the sinus by making an osteoplastic flap in the anterior wall.

2. Diseases and Injuries of the Larynx and Trachea.

Edema of the Larynx (Edema of the Glottis).—The **causes** of edema of the larynx are—acute laryngitis; chronic diseases, such as tuberculosis, malignant disease, or syphilis;

inflammatory disorders, such as diphtheria and erysipelas; acute infectious diseases; Bright's disease; aneurysm; whooping-cough; pneumonia; quinsy; wounds of the larynx; wounds of the neck; scalds and burns of the larynx, and the inhalation of irritating vapors, such as those of ammonia and sulphur. The **symptoms** are sudden and rapidly increasing dyspnea, respiratory stridor, huskiness of the voice, and finally aphonia. The swollen epiglottis may be felt with the finger and may be seen with the help of a mirror.

Treatment.—In cases in which edema of the larynx is not excessively acute, introduce a gag between the teeth, hold the mouth open, take a knife wrapped to within one-quarter of an inch of its point, make multiple punctures into the epiglottis, and favor bleeding by the inhalation of steam. In severe cases perform intubation or tracheotomy.

Wounds and Injuries of the Larynx.—The larynx may be injured internally by foreign bodies, and externally by blows and cuts. A condition often met with is *cut throat*, the result usually of a suicidal attempt on the part of the patient or a homicidal effort on the part of an assailant. The cut of the suicide is usually in front; as a rule, it misses the great vessels, but divides the cricothyroid or thyrohyoid membrane. The epiglottis may be incised, or even be cut off. If a large vessel is cut, death rapidly occurs. The immediate dangers of cut throat are hemorrhage, suffocation by blood in the windpipe and bronchi, or by displacement of parts, and entrance of air into veins. The secondary dangers are pneumonia, infection and sepsis, exhaustion, and secondary hemorrhage. The remote dangers are stricture and fistula (Keetley).

Treatment.—In wounds of the throat arrest hemorrhage, remove clots from the larynx and trachea, bring about reaction, asepticize the parts as well as possible, suture the deeper structures with silver wire, catgut, or kangaroo-tendon, and the superficial parts with silkworm-gut, dress antiseptically, and place a bandage around the head and chest so as to pull the chin toward the sternum. If laryngeal breathing is much interfered with, perform tracheotomy. Feed the patient through a tube until union is well advanced. The old method of leaving the wound open is to be condemned. When sutures are used primary union may be obtained. This fact was proved by Henry Morris.

Scalds of the Glottis (see p. 914).

Foreign Bodies in the Air-passages.—The lodgement of foreign bodies in the air-passages is a frequent acci-

dent. Small solid bodies are usually expelled by coughing. Liquids and solids rarely pass beyond the larynx (except in laryngeal disease or palsy, wounds of the floor of the mouth, cut throat, and in people unconscious or very drunk). In vomiting during or after the administration of an anesthetic, or in the vomiting of drunkards, the vomited matter may find its way into the larynx or lungs. There is great danger of this accident in an operation upon a patient with intestinal obstruction who has stercoraceous vomiting. In most instances of foreign bodies lodged in the air-passages it will be found that the object was being held in the mouth when a sudden deep inspiration was taken (often during laughter). The **symptoms** are *immediate*, due to obstruction by the body and to spasm, and *secondary*, due to the situation of the body and the changes it undergoes or induces.

Lodgement in the pharynx causes violent dyspnea. The body can be seen or felt.

Lodgement in the Larynx.—In a severe case the patient fights madly for air; his face becomes livid and cyanotic; his veins stand out prominently; speech is impossible, though he may make noises and utter harsh cries; violent coughing begins, and then vomiting; he tries to force a finger down his throat and clutches at his neck; sweat pours from him; he feels a sense of impending dissolution, and he falls unconscious, with incontinence of feces and urine.[1] In a less severe case violent dyspnea gradually departs and the patient lies exhausted; but dyspnea and cough are liable to recur suddenly at any time because of spasm, and they may be induced by a change of position. These attacks of fierce spasmodic cough are not at first linked with expectoration, but after inflammation begins there is a profuse and often bloody expectoration. Inflammation follows more rapidly the lodgement of a sharp or irregular body than it does that of a round or smooth body. Inflammation is apt to produce edema of the glottis, bronchopneumonia, or ulceration and necrosis of the larynx. Any sort of foreign body in the larynx may at any moment produce spasmodic dyspnea, and is always very liable to cause edema of the glottis. The body if bony or metallic can be detected by the *x*-rays.

Lodgement in the Trachea.—The immediate symptoms of a foreign body in the trachea depend on the shape and weight of the body, and whether it becomes fixed in the mucous membrane or moves to and fro with the air-current. A smooth, heavy body falls to the tracheal bifurcation, and, if

[1] See Moullin's graphic description in his *Treatise on Surgery*.

it does not enter a bronchus, moves with every breath, and by its movement causes violent laryngeal spasm, cough, and whooping inspiration without aphonia. The patient is often conscious of the movements of the foreign body, and the surgeon may detect them with the stethoscope. The foreign body may be found with the Röntgen rays. A foreign body in the trachea is liable to cause death by dyspnea, or it may ascend so as to be caught in the larynx, or may even be expelled. Irregular or sharp bodies lodge in the mucous membrane, produce inflammation, frequent cough, and expectoration, and finally lead to ulceration. Bodies which swell from heat and moisture tend to lodge and to become fixed (seeds may sprout).

Lodgement in a Bronchus.—Foreign bodies in the bronchi seriously endanger life. They usually lodge in the right bronchus. When a small lung-area is obstructed the obstructed side shows diminished respiratory movement and murmur with occasional whistling sounds and large moist râles; the percussion-note is normal. When an entire lobe is obstructed all respiratory sounds are absent over it, and over the unobstructed lung respiration is exaggerated; the percussion-note over the obstructed area is at first resonant, but becomes dull. The *x*-rays will enable the surgeon to detect some foreign bodies in a bronchus. Lodgement in a bronchus may cause bronchopneumonia, abscess, hemorrhage, and even gangrene. In some cases the body has been expelled spontaneously. In rare instances people have lived for years with lodged foreign bodies. If death does not soon follow the lodgement of a foreign body, an abscess is very apt to form.

Treatment.—If a foreign body lodges in the pharynx, try to pull it forward; if this fails, push it back into the esophagus. In lodgement in the larynx or below, if the symptoms are very urgent, at once perform a quick laryngotomy. If the symptoms are not so urgent, get a complete history of the accident and find out the nature of the foreign body. Be sure a foreign body is retained in the respiratory tract, and determine what its situation may be. Often a laryngologist can remove a foreign body from the larynx by means of forceps, a mirror and lamp being used for illumination. The fauces and upper portion of the larynx should have cocain applied to them to lessen pain and spasm. If the surgeon fails in extraction by forceps, and laryngotomy has been performed, continue the search through the opening in the cricothyroid membrane; if laryngotomy has not been performed,

let the larynx be opened by *thyrotomy* (a vertical incision between the alæ of the thyroid cartilage, and the separation of these alæ to permit of exploration). After a thyrotomy suture the perichondrium with catgut. If the foreign body is in the trachea, perform ordinary tracheotomy: if it is in a bronchus, perform low tracheotomy. Tracheotomy prevents suffocation from laryngeal spasm or edema of the glottis. It may be possible to remove the body in the bronchus through the incision of a low tracheotomy, and this ought to be tried. The foreign body may be expelled through the tracheotomy wound; if it is not expelled, search the trachea and bronchi with Gross's forceps, with probes, with hooks, or with the finger. If the foreign body cannot be found, put the patient to bed, and maintain a moist atmosphere in the room. As a rule, when the foreign body is not found insert a tube. If the foreign body be extracted, do not insert a tube (unless edema of the glottis exists or is likely to come on), do not suture the wound, but cover it with moist gauze and let it heal by granulation. Morphin and sedative cough-mixtures are given. Gross says that even when a foreign body has long been retained an operation should be performed so long as the air-passages are not seriously diseased. What shall be done when a foreign body is lodged in a bronchus and we are unable to extract it through a tracheotomy-wound? Truc said if "the patient is in danger of death" go through the chest-wall and attempt to remove the body. He said this with a full knowledge of the difficulty of locating the body. This difficulty has been partly overcome by the *x*-rays, and it seems now more certainly our duty to operate than it was a short time ago. Nasiloff proposed to reach the obstruction by the posterior route after rib resection. Curtis attempted this, and though the patient died, his operation proves that the method is feasible and should be performed at once, if low tracheotomy fails.

3. Operations on the Larynx and Trachea.

Tracheotomy.—The instruments required in this operation are scalpels, dissecting-forceps, a dry dissector, hemostatic forceps, scissors, a tenaculum, aneurysm-needle, tubes, tapes, Paquelin cautery, needles, needle-holder, a mouth-gag, tongue-forceps, foreign-body forceps, retractors, and, if membrane is present, feathers and a solution of bicarbonate of sodium. In a formal operation give chloroform, but in an emergency case this cannot be done. The patient

may be placed supine with a sand-pillow under the neck and with the head thrown over the end of the table. If a child, Liston used to wrap it up to the neck in a sheet to prevent movements of the limbs, would seat himself on a chair, place the child upon the nurse's lap, and takes its head between his knees. The head must be exactly in the middle line, and extended (in an adult this gives two and three-quarters inches of trachea above the manubrium; in a child of ten, two and a quarter inches; in a child of six, about two inches). The operator stands to the right side when the patient is supine. If bleeding is profuse when the surgeon is ready to open the trachea, place the patient in the Trendelenburg position with the neck extended. The trachea may be opened above or below the isthmus of the thyroid gland. The isthmus in an adult usually lies over the second and third rings (Fig. 251). The isthmus in a child

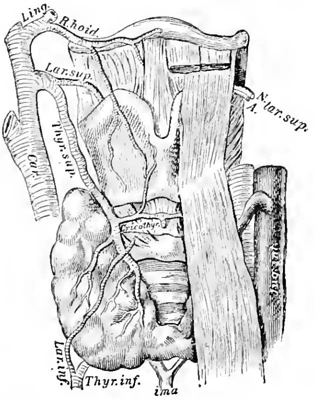


FIG. 251.—Blood-supply of the larynx and trachea (Esmarch and Kowalzig).

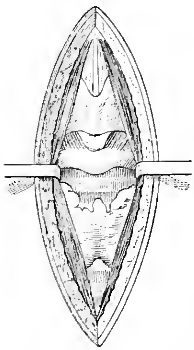


FIG. 252.—Parts exposed in tracheotomy (Esmarch and Kowalzig).

usually lies over the first ring or even over the space between the cricoid cartilage and the first ring. The high operation is always chosen except in cases where it is desired to search for a foreign body in a bronchus.

High Tracheotomy.—High tracheotomy is preferred because in this region the muscles are distinctly separated (Fig. 252), the main vessels of the neck and the inferior thyroid vessels are not encountered, the anterior jugular veins are small and have very few transverse branches, and the trachea is near the surface (Treves). The surgeon accurately locates the cricoid and thyroid cartilages. An incision

is begun at the upper border of the cricoid cartilage, and is carried down precisely in the middle line for about one and a half inches. Treves advises the operator to steady the skin of the neck with the fingers of the left hand and to cut with the unsupported right hand (if the hand be supported, the respirations will interfere with the operation). The skin, the superficial fascia, and the anterior layer of the cervical fascia are incised, the sternohyoid and sternothyroid muscles are separated, and the fascia over the trachea is divided. This fascia is attached above to the cricoid cartilage, and it divides below into two layers to invest the thyroid body and its isthmus. If veins are in the line of the incision, they are pushed aside, but it is not necessary to take the time to apply a double ligature. Even if bleeding is profuse, as soon as the trachea is opened and air enters freely into the lungs venous congestion is relieved and bleeding is apt to cease. If hemorrhage be violent and the veins are not at once caught by forceps, it may be well to place the patient in the Trendelenburg position before incising the windpipe, in order to prevent the entrance of blood into the lungs. Before opening the trachea the isthmus of the thyroid gland is pushed downward; if it cannot be pushed down sufficiently, a transverse incision is made through the fascia at the upper border of the cricoid cartilage, and the fascia, and the isthmus with it, are lifted off of the trachea (Bose's method). A tenaculum is inserted into the cricoid cartilage in order to steady the tube. The back of the knife is turned toward the sternum, a finger being held upon the blade to prevent too deep a cut being made. The knife is plunged, as if it were a trocar, into the mid-line of the trachea above the isthmus, and two or three rings are divided from below upward. The hook is not removed until the operation is completed. If a foreign body is present, an attempt is made to remove it; if success attends the effort, no tube need be worn; but if the body is not found a tube must be used. In croup or diphtheria remove membrane (by means of a feather and a solution of bicarbonate of sodium, ℥ij, glycerin ℥j, water ℥x—Parker) and insert a tube. The edge of the cut is grasped with the dissecting-forceps the mucous membrane being included in the bite, the head is placed erect, the tube is introduced, and the tenaculum is removed. Secure the tube by tapes, and suture the wound below the tube. Remove the tube at the first moment consistent with safety. In croup or diphtheria put a screen around the bed; have the air kept moist by steam; remove the inner tube and clean it every two or

three hours at first; clean the outer tube, and the larynx and trachea whenever required, by means of a feather and Parker's solution. A steam spray atomizer may be used with advantage.

Quick laryngotomy must never be attempted upon a child under thirteen years of age, because of the small size of the cricothyroid space before this age (Treves). In view of the difficulty of introducing a tube and of wearing it so near the vocal cords, laryngotomy should not be performed for croup, diphtheria, or for any condition in which a tube must be long worn. Make an incision an inch and a quarter long in the middle line, from above the lower edge of the thyroid to below the lower border of the cricoid cartilage. Divide the skin, superficial fascia, and deep fascia, separate the cricothyroid and sternothyroid muscles, divide the deep layer of fascia, and cut the cricothyroid membrane horizontally just above the cricoid cartilage. The tube must be shorter than the tracheotomy-tube. An operation which opens vertically the cricothyroid membrane, the cricoid cartilage, and the upper rings of the trachea is called "laryngotracheotomy."

Intubation of the Larynx (O'Dwyer's Operation).—Bouchot conceived the idea of intubation; O'Dwyer perfected it and made it a genuine scientific proceeding. The instruments required for the performance of this operation are a mouth-gag, an instrument to hold the tube and introduce it, an instrument for extracting the tube, and a graduated scale. The collar of the tube has a perforation through which a piece of silk is fastened to draw out the tube. The child is wrapped in a sheet to secure the limbs, is seated in a nurse's lap, and its head is held by an assistant. The jaws are to be opened and held apart by the self-retaining mouth-gag. The surgeon sits in front of the patient, wraps a piece of rubber plaster about the index-finger of his left hand, and passes the finger into the child's mouth until it touches the epiglottis. He introduces the holder and tube (observing if the silk is free) along the surface of the tongue until the obturator touches the epiglottis; raises the epiglottis with the left index-finger, and passes the tube into the larynx; places the left index-finger against the tube, and withdraws the holder with the right hand. The silken thread is tied to the ear, and the nurse is directed to employ the thread to remove the obturator if it becomes obstructed or is coughed up. The tube is removed in two or three days; if breathing is easy, it is not reintroduced, but if

dyspnea recurs, it is replaced for two or three days more. If, in introducing the tube, a mass of false membrane is pushed before it into the trachea, breathing ceases, and, if the mass is not at once coughed up, tracheotomy must be performed. Wharton feeds these patients on semisolids rather than upon liquids (mush, soft eggs, and corn-starch); and if trouble occurs in swallowing these articles, he feeds by the rectum or by means of a tube. In opium-poisoning, in asphyxia, in acute traumatic pneumothorax, and in cerebral injuries, intubation may be associated with the use of Fell's apparatus (p. 729).

4. Diseases and Injuries of the Chest, Pleura, and Lungs.

Pleuritic effusion may arise from the lodgement of foreign bodies, from injury by fragments of a broken rib, from tumors, and from inflammation of the lung, but most usually is due to pleuritis. A common cause of pleuritis is tuberculosis. Inflammatory effusion is nearly always unilateral (except in tubercular pleuritis, but even this form is one-sided in origin).

The **signs** of pleuritic effusion are—dulness on percussion over the effusion, this dulness, when the patient is erect, being at the lower part of the chest and ascending higher posteriorly than anteriorly (alteration of position alters the situation of the dulness); the intercostal spaces are widened and the intercostal depressions are obliterated; no breath-sounds can be detected in the area of flatness when the collection of fluid is large, but in small effusions deeply situated the breath-sounds are often audible; the percussion-note above the liquid is hyper-resonant or tympanitic, and is often associated, at the edge of the liquid, with a friction-sound; posteriorly, high up and near the spine, there are bronchial respiration and bronchophony (J. M. DaCosta). In these cases pain disappears with the advent of effusion, dyspnea comes on, and the patient lies upon the diseased side. Cough always exists, and fever is usually present. In serous effusions the diagnosis may be confirmed by the introduction of an asepticized aspirating-needle.

The **treatment** in this stage is to discontinue arterial sedatives and to stimulate if the circulation calls for it. The exudation is removed by the administration of salines, compound jalap powder, or elaterium. If these means fail, if the effusion is excessive, or if it is producing dyspnea, at

once aspirate. Aspiration should be performed for an effusion which fills the whole chest, which produces great dyspnea, or which has lasted for three weeks. In tubercular pleuritis early aspiration is not advisable, but aspiration should be performed if the fluid becomes purulent, if the effusion displaces the heart considerably, and if it adds notably to the dyspnea. If pus forms, the proper procedure is incision, resection of a rib, and drainage.

Empyema is a collection of pus in the pleural cavity. It may begin suddenly, but rarely does so. Among the causes of empyema are those of serous effusion. Empyema is due to infection of the pleura, and in every case a bacteriological study should be made of the pus to discover the causative organism. The pneumococcus is the causative organism in many of the cases which follow pneumonia. This organism lives but a short time, and in empyema due to pneumococci these organisms may not be discoverable when the pus is evacuated. In most cases of empyema streptococci or staphylococci can be found in the pus. These organisms may appear in an empyema induced originally by pneumococci (Stephen Paget). In empyema developing during or after typhoid fever the typhoid bacillus may be discovered. In putrid empyema various bacteria are found. Bouchard thinks acute empyema has a special organism. The bacilli of tuberculosis are present in tubercular empyema, but may disappear after mixed infection with pyogenic bacteria. Empyema may be due to a wound or contusion, an attack of pneumonia, tubercular pleuritis, phthisis, influenza, infection of a serous effusion, caries of a rib, specific fevers, especially typhoid, peritonitis, abscess of the liver, suppurating hydatid cyst of the liver, subphrenic abscess, malignant disease of the pleura, gangrene of the lung, and pneumothorax. The **signs** are in reality those of pleuritis with effusion, viz., dulness on percussion, absent breath-sounds over the purulent matter, bulging of the intercostal spaces, and sometimes edema of the skin of the chest. The **symptoms** of acute empyema are dyspnea, pallor, cough, sweats, chills, and usually irregular fever, but fever may be absent. There is marked leukocytosis. The fingers may become clubbed. An empyema of the left side may pulsate. A neglected empyema may break into the lung, esophagus, or pericardium, through an intercostal space, or may point in the lumbar region. When an empyema is pointing externally, the condition is called empyema necessitatus. After an empyema ruptures spontaneously it rarely heals without

surgical interference, a fistula, as a rule, persisting. When an empyema ruptures into a bronchus, pneumothorax arises as a rule. Empyema may cause death by compression of the heart and lung, pulmonary embolism, pericarditis, peritonitis, cerebral embolism, cerebral abscess, septicemia (Stephen Paget), exhaustion, or rupture into a bronchus.

A small empyema due to pneumococci occasionally, though very rarely, undergoes spontaneous cure, the pus being absorbed (Stephen Paget).

A small empyema is occasionally cured by encapsulation with fibrous tissue.

Under exceptional circumstances, even a large empyema may be cured by breaking externally or into a bronchus. A subphrenic abscess may follow an empyema.

Empyema is so rarely cured spontaneously that it does not do to trust to Nature, and practically almost every case will die without surgical treatment.

Double empyema is a rare and extremely fatal condition. There are two forms of empyema, the acute, which comes on as a violent inflammation, and the chronic.

Chronic empyema may follow an acute empyema, or the condition may be chronic from the beginning. In chronic empyema the lung is compressed, shrunken, and strongly adherent, and the pleura is very thick. In some cases the pleura is over an inch thick. This thickening is brought about by the deposition of layer after layer of fibrin. In not a few cases a chronic empyema succeeds an acute one or is itself maintained because a drainage-tube has slipped into the pleural cavity and remains lodged.

A closed empyema is one in which no opening has been made by the surgeon and no opening has formed spontaneously. In a closed empyema the pus is rarely putrid; in an open empyema the pus is often putrid.

Treatment of Empyema.—The treatment is purely surgical, and the earlier it is applied the better. To delay allows the pleura to thicken and permits adhesions to form, conditions which prevent lung expansion and retard or even prevent cure. The results of operation are better in children than in adults; in small collections than in large; in recent than in advanced cases; in pneumococcus empyema than in empyema due to other organisms. The surgical treatment comprises aspiration, incision, rib-resection, the operation of Schede, and the operation of Estlander (see p. 738).

In acute empyema general practitioners are very apt to aspirate, and yet aspiration is almost never curative. It may

cure a pneumococcus empyema in a child, and an encysted empyema, but even in these it will usually fail. Aspiration is not to be considered a method of curative treatment. It is to be regarded as the surgical treatment only in a tubercular empyema in a young person with rapidly progressing phthisis, because in such a case incision will prove fatal (Lockwood). It is a very useful diagnostic expedient, and enables the surgeon to prove the existence of pus, and the pus which is obtained can be examined bacteriologically. In a very large effusion it is wise to aspirate and withdraw part of the effusion a day or two before operating. This enables the patient to take an anesthetic with greater safety and obviates the danger attending the rapid evacuation of a large amount of pus.

In a recent empyema incision and drainage or rib resection and drainage will often cure the case, and yet many of the results are unsatisfactory. In some cases the discharge ceases and yet pulmonary function is not completely restored. In other cases a pleural fistula persists. If a profuse discharge is maintained, amyloid disease may arise. An acute empyema is to be drained by intercostal incision or by resection of a rib. A chronic closed empyema is drained in the same manner, and if the lung will not fully expand and remains stationary for a month Schede's or Estlander's operation is required. An open chronic empyema, in which the lung will not expand, requires the operation of Schede or Estlander. When there is an external opening which persists, and which joins a long, narrow cavity, the condition is spoken of as pleural fistula, and pleural fistula is often produced by the prolonged use of a drainage-tube and sometimes by caries of a rib. A pleural fistula may sometimes be cured by dilatation of the sinus, but in most cases it is necessary to resect one or more ribs. Even if there is no opening on the cutaneous surface, there may be one into a bronchus. In total empyema the entire sac of the pleura is involved; in partial or localized empyema the purulent matter is encapsuled.

Non-traumatic Pneumothorax.—By the term pneumothorax is meant the presence of air in the pleural cavity. As a rule, besides air there is serous fluid or pus. It may be due to the rupture of an empyema into a bronchus; to the rupture of a tubercular area, an area of gangrene, an abscess of the lung, an air-cell in a state of emphysema, or of pulmonary tissue softened because of hemorrhagic infarction. The immediate effect of the entrance of air into the pleural sac is to compress

the lung, the degree of compression being in proportion to the amount of gas present. In severe cases the lung is squeezed against the vertebral column, and the heart, the diaphragm, and even the liver are displaced. In some cases, where the admission of air does not continue, the amount already in the pleural sac is absorbed. In most cases pyo-pneumothorax (empyema) follows.

Symptoms.—The symptoms usually arise suddenly, and consist of distressing dyspnea, pain in the chest, lividity, and rapidity and weakness of the pulse. In some cases of phthisis the symptoms are not very severe. It has been pointed out that occasionally in phthisis pneumothorax seems to actually benefit the tubercular area in the lung. The physical signs of pneumothorax are as follows: the affected side of the chest is bulged and immobile, and the heart is displaced, especially if the condition affects the left side. Palpation discovers that vocal fremitus is lessened or absent. The percussion-note is tympanitic. In some rare cases the percussion-note is dull. When fluid gathers there is a positively dull note on percussion over the fluid. On auscultation it is found that the breath-sounds are very feeble or absent. The voice is transmitted as a metallic sound, the râles sound metallic, and on coughing there may be metallic tinkling.

Treatment.—Osler says the treatment should be the same as that of pleurisy with effusion. In many cases it is wise to aspirate and remove air and serous effusion. If pus forms, a rib should be resected and a tube inserted (see Empyema). In pneumothorax occurring during chronic phthisis operation is of great service. In cases with rapidly progressive phthisis it is practically useless.

If there is an opening in a bronchus, aspiration will not get rid of air; the air will enter into the pleura as rapidly as the aspirator removes it. Incision has dangers of its own: the diaphragm is flapping during respiration and may be injured (Fowler), and when the pleura is opened there is a great alteration produced in the air-pressure in the chest, and the patient may "drown in his own secretions." After incision irrigation is not justifiable, because the fluid may enter a bronchus and produce suffocation (Fowler).

West's rule is a good one[1]—that is, early incision is dangerous. In an early stage use paracentesis without suction. This will often relieve the patient. If paracentesis does relieve him, wait awhile and perhaps repeat the oper-

[1] *Brit. Med. Jour.*, November 27, 1897.

ation if the symptoms again became severe. If paracentesis does relieve, incise, resect a portion of a rib, and drain. If pus forms, an incision must be made and a portion of a rib resected, to afford exit to the fluid.

Fowler points out that if the lung is bound down by adhesions, incision is dangerous but justifiable. Operation at the proper time often prevents the lung being bound down by adhesions.

Acute Traumatic Pneumothorax.—This is produced by the sudden admission of a quantity of air into the pleural cavity as a result of a wound of the chest-wall. A small quantity of air, or the gradual introduction of considerable air does not, as a rule, produce very serious symptoms. The sudden admission of a quantity of air causes very dangerous symptoms, and even death. A quantity of air may be admitted rather suddenly as a result of an accident or during the performance of a surgical operation which opens the pleura. It sometimes arises during the removal of tumors from the chest-wall, during operations upon the lung, and during empyema operations. As a rule, when pulmonary adhesions exist, dangerous symptoms do not arise, even when the pleura is widely opened, and adhesions exist in 25 per cent. of empyema cases seen by the surgeon.[1]

It used to be taught that whenever the pleura is opened there is a strong tendency to the development of pneumothorax, but West has shown that the surfaces of the pleura often cohere with a force superior to pulmonary elasticity, and in such cases pneumothorax does not arise.

Symptoms.—When the pleura is opened during an operation or by an injury, the symptoms may be trivial and transitory, may be tolerably severe, may be extremely grave, and the patient may quickly die (Quénu and Longuet). Rudolph Matas sets forth the symptoms as presented by the French observers:[2]

The mild symptoms are a weak, slow pulse and irregular, noisy respiration.

The severe symptoms are slow pulse, slow and irregular respiration, and dyspnea, continuing after the anesthetic has been withdrawn.

The grave symptoms are cyanosis; collapse; small, weak pulse; shallow and noisy respiration; and spells of syncope. Death may occur suddenly from inhibition, or later from mechanical asphyxia (Matas).

[1] Rudolph Matas, *Annals of Surgery*, April, 1899.
[2] *Annals of Surgery*, April, 1899.

Treatment.—Various plans have been adopted: suturing the opening in the pleura; plugging the opening; pulling the diaphragm into the wound in the chest-wall and suturing it; and grasping the lung and suturing it to the wound. Whenever the pleura is widely opened, follow the advice of Matas and use the Fell-O'Dwyer apparatus, and when the operation is completed, suture the lung to the margin of the opening in the pleura with a continuous catgut suture. Parham has followed this plan and the lung was kept from collapsing.[1]

The Fell-O'Dwyer apparatus is shown in Fig. 253.

O'Dwyer's tube is introduced into the glottis and is attached to a bellows, the lung is inflated, respiration is maintained by the use of the bellows, and collapse with all its dangers is avoided.

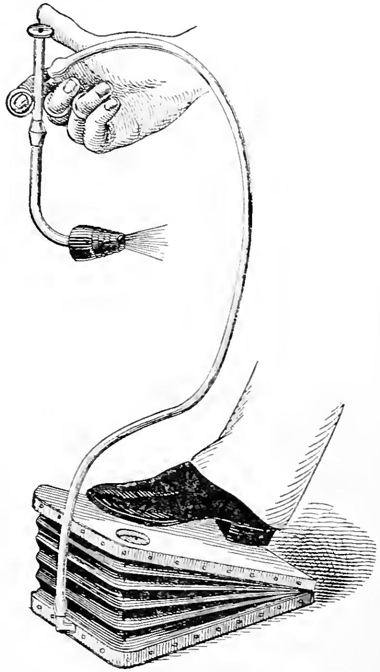


Fig. 253.—The Fell-O'Dwyer apparatus. This illustration shows an early model; since then the bellows have been improved by the addition of a strong wooden frame which holds it steadily, and is provided with a long arm that acts as a powerful foot-piece for compressing the machine with the least amount of muscular effort.

Contusions and Wounds of the Chest.

—**Contusions.**—A contusion may be trivial and limited to the superficial parts of the chest-wall; it may involve the muscles; it may be associated with fracture of the ribs or sternum or with visceral injury.

Symptoms.—In an ordinary contusion without visceral injury there are considerable pain, discoloration, and often much swelling. The patient prefers to lie upon the back and the respiration is abdominal. After a severe blow upon the chest there is great shock and may even be instant death. The condition of shock so produced is called concussion of

[1] F. W. Parham's paper on "Thoracic Resection for Tumors Growing from the Bony Walls of the Chest." Read before the Southern Surgical and Gynæcological Association, November, 1898.

the chest. Broken ribs may injure the pleura or lung. After a severe blow upon the chest a limited area of inflammation may arise in the pleura (traumatic pleuritis). Severe visceral injury is announced by positive symptoms. A *contusion of the lung* causes pain, cough, expectoration of bloody mucus, dyspnea, and possibly distinct hemoptysis. Over the contused region the percussion-note is dull and on auscultation crepitus is audible. A limited pneumonia follows, but genuine croupous pneumonia may arise.

In **rupture of the lung,** besides the symptoms above noted, there are hemothorax and pneumothorax.

Rupture of the diaphragm causes pain and dyspnea, and often vomiting. The stomach or intestine may pass into the pleural sac. If this happens, there will be a tympanitic percussion-note over the displaced viscus and symptoms will vary with the viscus involved. In a case in the Jefferson Medical College Hospital, in which the stomach passed into the left pleural sac, there were persistent vomiting, violent pain in the chest, and displacement of the apex-beat. Such a diaphragmatic hernia may become strangulated.

Treatment of Contusions of the Chest.—An ordinary contusion is treated as directed in the section on Contusions (p. 204), and the chest is strapped with adhesive plaster, as in the treatment of fractured ribs. In concussion of the chest the treatment for shock is applied. It may be necessary to employ artificial respiration for a time. If a diaphragmatic hernia is diagnosticated, the abdomen should be opened, the displaced viscera restored to their proper abode, and the diaphragm sutured. The diaphragm may also be reached by resecting several ribs and opening the pleural sac. In contusions of the lung cold is applied to the chest, and any inflammation which arises is treated according to general rules. In rupture of the lung the case may be treated expectantly, but dangerous and continued bleeding or pneumothorax may render surgical interference necessary.

Wounds of the Chest.—Non-penetrating wounds are not particularly grave, and are treated according to general principles, the chest being immobilized. Penetrating wounds are extremely grave, as viscera are apt to be injured. In such a wound an intercostal artery may be severed or the internal mammary artery may be divided. An intercostal artery is rarely divided unless a rib is broken. The surgeon should always examine carefully in order to determine whether an intercostal artery or the internal mammary artery has been divided, and, in doing so, should bear in

mind the admonition of Matas, that is, the bleeding from one of these vessels may be internal, the blood collecting in the pleural sac. The pericardium or heart may be injured (p. 303). A wound of the pleura is usually, but not always, associated with a wound of the lung. If the lung is injured, there are usually great shock, pain in the chest, dyspnea, and cough. In a large wound damage to the lung will be indicated if air is sucked into the wound during inspiration and expelled during expiration, and blood is forced out of the wound by coughing. The lung may be visible or may protrude (hernia of the lung). In a small wound it is often difficult and sometimes impossible to determine whether the lung has been injured. Pneumothorax with pulmonary collapse proves it has. Severe hemothorax strongly suggests it. Spitting blood does not prove it. In some severe cases there is no hemoptysis; in some slight bruises the amount of blood coughed up is large. Emphysema about the wound does not prove lung injury. An incised wound of the lung is apt to produce rapid death from hemorrhage, especially if the wound is at the root of the lung. A pistol-bullet or a sporting-rifle bullet is not usually productive of great primary hemorrhage; but infection usually follows, and secondary hemorrhage is apt to occur. The modern military-rifle ball passes through, rarely lodges, is aseptic, and often produces astonishingly little trouble. A pistol-bullet and an old-time rifle bullet may lodge or may perforate.

Treatment.—Bring about reaction as pointed out on page 207.

In an incised wound, if the wound is large, carefully inspect it. If the wound is small, cut down layer by layer until the depths of the wound are reached. Disinfect the wound and arrest hemorrhage. If the pleura is not open, proceed according to general rules (p. 209). If the pleura is found to have been opened, suture it with catgut, close the superficial wound, dress with gauze, and immobilize the chest-wall.

The above proceedings should be carried out whether it is or is not believed that the lung has been damaged, provided there is no pneumothorax and no violent hemorrhage. What course shall be pursued if the lung has been injured by a stab? If hemorrhage does not threaten life and there is no pneumothorax, the patient is kept at rest and observed. If pneumothorax occurs, the pleural sac must be drained by means of a tube, because clots must be evacuated and infec-

tion should be anticipated. If hemorrhage into the pleural sac persists, active measures become necessary. The use of ice-bags and drugs is but waste of time. Some surgeons believe that the mere closure of the external wound leads to arrest of hemorrhage, blood accumulating and making pressure. It is true that hemorrhage often ceases after suturing or plugging a wound and strapping the chest, but it is not probable that it ceases because of these measures. Blood in the pleura will not clot for many days. Further, as Le Conte shows, as the blood is forced against the root of the lung, the right heart is engorged, the blood-pressure is raised, and the bleeding continues.[1]

Bleeding from the lung can often be arrested by inserting the end of a drainage-tube into the pleural sac. In cases where a drainage-tube is inserted into the pleural cavity and free drainage established, the pleura is immediately filled with air, and the muscles of respiration are kept from acting on the lung. The lung contracts by its own elastic tissue, as well as by the pressure exerted by the pneumothorax, and at the same time the presence of the air favors clotting in the severed vessels.[2] If the insertion of a tube fails, or if the bleeding is rapid and obviously seriously threatens life, several ribs must be rapidly resected and the bleeding part explored. In some cases the bleeding may be arrested by ligation, in some cases by packing a small wound with gauze, in some cases by the suture ligature. In a violent secondary hemorrhage following a gunshot-wound of the lung the author packed the entire pleural cavity with sterile gauze to obtain a base of support, and arrested the bleeding by carrying iodoform gauze directly against the oozing surface.[3] After arresting hemorrhage in hemothorax, turn out the clots and employ drainage. In a perforating wound inflicted by a bullet, reaction must be brought about, the wound should be dressed antiseptically, the chest should be strapped, and the patient kept quiet. If pneumothorax occurs, the pleura should be drained with a tube. If hemorrhage occurs, it should be met as directed above. In a wound in which the bullet has lodged an examination should be made to see if the bullet is under the skin and if it is, it is removed after the patient has reacted. It should always be borne in mind that a pistol-bullet may be deflected by a rib or may pass from the front to the back part of the chest by making

[1] *Annals of Surgery*, April, 1899.
[2] Le Conte, in *Annals of Surgery*, April, 1899.
[3] *Annals of Surgery*, Jan., 1898.

a burrow under the skin (a contour wound). If a bullet is lodged, no attempt should be made to remove it unless an operation must be done for bleeding, unless the bullet causes trouble, or unless it is felt under the skin. Under no circumstances conduct a long search for a bullet. If emphysema of the chest-walls is moderate, strapping or a bandage will control it; if it is great, make multiple punctures and then apply pressure. In hernia of the lung try to restore the protrusion; but if restoration is impossible or if gangrene seems highly probable, ligate the base of the protrusion with silk and cut away the mass.

Abscess of the lung may follow ordinary pneumonia. It is apt to follow aspiration-pneumonia. Osler tells us that it may be caused by the aspiration of septic particles after "wounds of the neck, operations upon the throat," and suppurative lesions of the nose, larynx, or ear. Cancer of the esophagus may be a cause, so may perforation of the lung by an abscess, wound of the lung, impaction of a foreign body in the lung, suppuration about a focus of tubercle or metastatic abscess.[1]

Symptoms.—The physical signs of a large cavity are found, and there is profuse and extensive expectoration, the expectorated matter containing portions of lung-tissue. Pyemic abscesses are hard to diagnosticate.

The **treatment** is purely surgical (pneumotomy). Make an incision over the cavity. Resect a portion of one or more ribs. Expose the pleura. If the two layers of the pleura are not adherent, suture them together and wait two days. If they are adherent, proceed at once. Search for the abscess with an aspirator needle. When the cavity is found, open into it with the cautery and insert a drainage-tube.

Gangrene of the Lung.—This term means the putrefaction of a devitalized portion of pulmonary tissue. It may follow pneumonia, or may be due to diabetes, to embolism of the pulmonary artery, bronchiectasis, tuberculosis, or malignant disease.

Symptoms.—The symptoms of a cavity exist; horribly offensive sputum, which contains fragments of lung-tissue and often altered blood, is expectorated; there are some fever and great exhaustion. The fetor of the discharge is characteristic, and is much more intense than the fetor of abscess.

The **treatment** is to operate as for pulmonary abscess.

Tubercular Cavity in the Lung.—Surgical Treatment.—For the past decade surgical thought has been

[1] See Osler's *Practice of Medicine*.

actively directed toward placing on a scientific footing operations for pulmonary phthisis. The matter is still in a transition-stage, and operations at present have but a very limited field of application, although Sonnenberg and others have reported cures. Mosler, a number of years ago, attempted to treat cavities by introducing a trocar into the cavity and injecting permanganate of potassium solution through the cannula. Patients were not benefited by this procedure. Hillier tried injection of corrosive sublimate into the lung-parenchyma, but the effect of the injections was disastrous. When the strength of the patient is well preserved and the pulmonary lesion is circumscribed and slowly progressive it may be justifiable to perform an operation, open the cavity, and treat it directly (pneumotomy). Fowler says it is not justifiable to operate if the disease has come "to a standstill." The same surgeon states that the only accessible region is bounded above by the clavicle, to the inner side by the manubrium, to the outer side by the lesser pectoral muscle, and below by the second rib.[1]

Mauclaise says that pneumotomy is only justifiable in circumscribed tubercular cavities without peripheral infiltration and in pulmonary abscesses.[2] Bronchiectatic cavities are usually multiple; they are excessively difficult to locate, and treatment by pneumotomy should not be attempted. In the treatment of pulmonary tuberculosis resection of the diseased area has been proposed (pneumectomy). Tuffier successfully performed this operation. Surgeons, as a rule, do not believe in pneumectomy. Reclus voices the general opinion when he says the operation is not required if the area of disease is very limited, as such a condition is frequently curable by medical means, and it does no good if the area of disease is extensive.[3]

It has long been known that pneumothorax might benefit a tubercular lung. Attempts have been made by Farlanini and Murphy to cure phthisis by the deliberate production of pneumothorax. Murphy injects nitrogen gas into the pleural sac, and believes that the method is of great value.

It has been suggested that in extensive unilateral tuberculosis of the lung resection of a number of ribs will favor cure by permitting retraction of the chest-wall.[4]

[1] See the very full and thoughtful article of George Ryerson Fowler on "The Surgery of Intrathoracic Tuberculosis," *Annals of Surgery*, Nov., 1896.

[2] *La Tribune médicale*, Sept., 21, 1893.

[3] *Revue de Chirurgie*, Nov. 11, 1895.

[4] Allis, to State Med. Soc. of Penn. in 1891.

Operations on Pleura and Lung.

Exploratory Puncture of the Pleural Sac.—Puncture often gives valuable information as to the existence of fluid in the pleural sac and as to the nature of the fluid. The operation must be performed with aseptic care, otherwise a serous effusion might be converted into a purulent effusion, and either a serous or a purulent effusion might be rendered putrid. A large hypodermatic syringe with a long and strong needle is used for exploratory puncture. A slender needle breaks easily, and is unsafe. In order to prevent breaking of the needle impress upon the patient the absolute necessity of keeping quiet and avoiding any violent respiratory or general movement during the operation. It is not desirable to stick the lung, although harm rarely results from such an accident. If no fluid is found in the pleura on one trial, several other punctures should be made. What is known as a dry tap may be due to the entire absence of fluid, to encapsulation of fluid in a region not invaded by the needle, to the lodgement of the point of the needle in thickened pleura or in an adhesion, or to blocking of the lumen of the needle with coagula. Fowler points out that if a person has been recumbent for a long time the upper layer of fluid may be clear while the lower layer is purulent.[1] The fluid should be collected in a sterile glass tube and subjected to a careful bacteriological study.

Paracentesis Thoracis.—The operation of tapping with a trocar is no longer practised except in an emergency when an aspirator cannot be obtained or in an early stage of non-traumatic pneumothorax. An aspirator is a much better instrument.

Aspiration.—Aspiration consists in the introduction into the pleural sac of the tip of a hollow needle, the other end of which is attached by means of a rubber tube to a bottle from which the air has been exhausted. The fluid does not run out, but is sucked out, air is excluded, and bacteria do not enter the pleural sac. Fig. 202 shows a pneumatic aspirator. No anesthetic is required. The skin, the instruments, and the surgeon's hands must be thoroughly asepticized. Give the patient a little whiskey, and, unless he is very weak, make him assume a semi-erect attitude. The arm hangs by the side, and the needle is introduced in the fifth interspace, just in front of the angle of the scapula. The surgeon marks the upper border of the sixth rib with the index-finger, and plunges in the needle just above the finger, thus avoiding

[1] *Annals of Surgery*, Nov., 1896.

the intercostal artery, which lies along the lower border of the rib above. He guards the needle with the index-finger to prevent its going in too far. The fluid is allowed to flow rather slowly in order that the patient may escape syncope and violent cough. If the patient becomes very faint, the operation should be abandoned. All the fluid present should not be removed at one sitting—complete removal of a large effusion is not safe. The operation can be repeated if necessary. After withdrawing the needle place iodoform collodion over the opening in the chest. In an early stage of non-traumatic pneumothorax perform paracentesis without suction. In pleuritic effusion, if the lungs will not expand after tappings, perform thoracotomy.

Thoracotomy is an incision into the cavity of the pleura. It may be merely an intercostal incision, or may be an opening into the chest after resecting a portion of a rib. Often in a child with empyema good drainage can be obtained by an intercostal incision, but in most children and in all adults a rib should be resected. The instruments required are a scalpel, a grooved director, forceps (hemostatic and dissecting-), scissors, a dry dissector, retractors, bone-instruments (in case rib-excision is required), drainage-tubes, and needles.

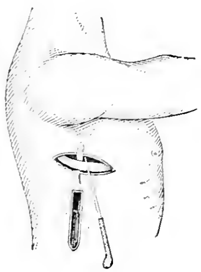


Fig. 254.—Resection of a rib (Esmarch and Kowalzig).

If there is very little dyspnea, ether can be given. If there is considerable dyspnea, chloroform should be given. If there is severe dyspnea, no general anesthetic is admissible. In severe dyspnea the patient is using certain voluntary muscles to aid him in obtaining air. A general anesthetic abolishes the activity of the voluntary muscles of respiration, and so might cause suffocation. In such cases the operation can be done with fair satisfaction after the injection of eucain or after infiltrating the superficial tissues of the chest-wall with Schleich's fluid, or, what is better, aspiration can be performed. Aspiration will permit of the subsequent administration of a general anesthetic. The patient on whom thoracotomy is to be performed is placed supine, the diseased side being at or over the edge of the table. He must never be placed on the sound side, because he breathes only with that side, and pressure on it may be dangerous.

The arm of the diseased side should be elevated to a right angle with the body. If the surgeon desires to make only

intercostal drainage, he should make a longitudinal incision about three inches in length at the upper border of the sixth or seventh rib, and the middle of this incision should correspond to the midaxillary line. This incision is carried, layer by layer, to the pleura. If, as will usually be the case, he wishes to remove a portion of a rib, he will make an incision about three inches in length directly upon the outer surface of the rib he wishes to remove, and the middle of this incision corresponds to the midaxillary line. Some surgeons resect a portion of the fifth rib, some remove a bit of the eighth rib, and Munro[1] shows that at the level of the eighth rib there is no danger of injuring the diaphragm. By many operators a portion of the seventh or eighth rib is removed in front of the line of the posterior axillary fold.

I agree with Hutton that a portion of the sixth rib in the midaxillary line should be removed.[2] The reasons given by Hutton for the selection of this region are: 1. It is over the portion of the lung which expands last. An empyema is drained only partly by gravity, and the fluid is really forced out and the cavity obliterated by lung expansion. If an incision is made anterior or posterior to this point, the expanding lung will block the drainage-opening, and a pus-cavity without drainage will remain in the midaxillary line. 2. Such an incision permits a patient to lie on his back without making pressure on the drainage-tube.

The periosteum of the outer surface of the rib must be divided in the same direction as the superficial incision. The exposed rib is stripped of periosteum front and back by means of a periosteal separator, and with the periosteum at the lower border of the rib the intercostal artery is lifted out of harm's way. The rib can be divided by means of cutting forceps, a chain-saw, or a Gigli saw. The usual method is to push a periosteal separator under the rib, and saw the bone in two places by means of a metacarpal saw. An inch or more of rib should be removed. The pleura should now be opened. The opening of the pleura is carried out in the same way in intercostal incision and after rib-resection. A grooved director is pushed into the pleural sac, and the opening is enlarged by means of the forceps and the finger.

The finger removes all masses of tubercular material or aplastic lymph within reach. If the finger finds the lung bound down with dense adhesions so that it cannot expand,

[1] *Medical News*, September 2, 1899.

[2] See W. Menzies Hutton on "Empyema," in *British Medical Journal*, October 29, 1898.

simple rib-resection will not cure, and Estlander's or Schede's operation should be done. Some surgeons advocate immediate irrigation, but this procedure is unsafe. It is true that in most cases irrigation does no harm, but in no case will it sterilize the cavity, and in some cases it is very dangerous. The pleura is very susceptible to the action of irritants. This is especially true of young children. It happens occasionally that the injection of even the blandest fluid is followed by intense dyspnea, great shock, disturbances of respiration and circulation, convulsions, and even death (Quénu). The convulsions which occasionally follow pleural irrigation were called by de Cerenville pleural epilepsy. In putrid empyema it is proper to irrigate. Irrigation will remove part of the actively poisonous putrid matter, and the retention of putrid matter is a greater danger than irrigation. It used to be rather a common custom to make a counter-opening by cutting down upon the long probe pushed against the chest-wall after being introduced through the incision, but a counter-opening is of no particular use. A drainage-tube about two inches in length is introduced and stitched in place. The tube must not be long enough to touch against the lung. A safety-pin is clamped upon the tube to keep it from slipping into the chest. A tape should be fastened to each side of the tube and tied about the chest to prevent it from slipping out. Arrest bleeding, suture the skin, dress with gauze, wood-wool, and a binder, and have the dressings changed as soon as they become soaked at one point. Several times a day change the patient's position. At each change of dressings direct him to lie on the diseased side for half an hour, and with the foot of the bed raised for half an hour. Healing takes place by ascent of the diaphgram, expansion of the lung, and retraction of the chest-wall. Expansion of the lung is favored by expiratory acts; hence cause the patient several times a day to blow into a wash-bottle filled with water. Remove the tube when the discharge becomes thin and scanty (about the eighth or tenth day, as a rule). If the lung was found bound down with adhesions so that it cannot expand to fill the space vacated by the pus, perform the operation of Schede or Estlander. If an empyema ceases to improve and remains stationary for four to six weeks after it has been drained, firm adhesions exist.

Thoracoplasty (Estlander's Operation) is a method of thoracoplasty, and is employed in old cases of empyema in which drainage has failed, and in cases with retracted chest-walls, collapsed lungs, thickened pleura, and cavi-

ties whose rigid walls will not collapse. The procedure recognizes the fact that after pus is evacuated, if the lung is adherent, it cannot expand to fill the space once occupied by fluid, and that the rigid chest cannot fall in as a substitute for the lung. It seeks to destroy the rigidity of the chest and to permit it to collapse and thus obliterate the cavity of the empyema. When the surgeon resects a rib and finds a cavity with uncollapsable walls, or a lung bound down with firm adhesions, he should perform thoracoplasty. This operation causes the obliteration of the cavity by collapsing that portion of the chest-wall overlying it. The cavity is in the upper or central part of the pleural space (Treves). The instruments required are the same as those for resection of a rib. The position is the same as that for rib-resection. The length of the incision depends on the size of the cavity. The surgeon usually removes portions of the second, third, fourth, fifth, sixth, and seventh ribs. Make a transverse incision along the center of an intercostal space, and through this incision remove the ribs above and below by the method set forth on page 736 (the removal of six ribs will require three incisions). Instead of this incision, we can make a vertical incision or a U-shaped flap. Always take away the periosteum in order to prevent reproduction of the ribs. Treves recommends that the cavity be at once washed out with corrosive sublimate (1 : 1000). In cavities which are surrounded by firm adhesions, and in old cases in which the pleura is greatly thickened, irrigation is safe. If the cavity is small, it should be packed with iodoform gauze and allowed to granulate; if large, it should be drained by a large tube, the skin being sutured by silkworm-gut.

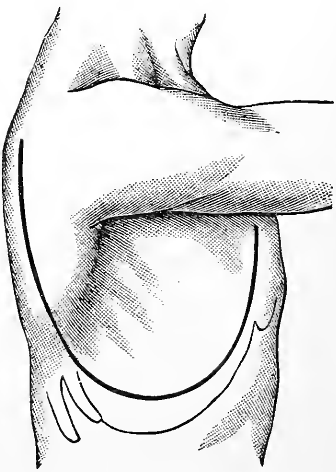


FIG. 255.—Incision for Schede's operation of thoracoplasty (Esmarch and Kowalzig).

Schede's Operation.—Schede showed that when the pleura is much thickened even Estlander's operation will not permit the chest-wall to collapse and fill the cavity once occupied by the fluid. The instruments used are the

same as for Estlander's opertion, plus bone-shears. A U-shaped flap is made from the level of the axilla in front to the level of the second rib and between the scapula and spine behind. The lowest level of this incision corresponds to the lowest limit of the pleura (Fig. 255). The flap is loosened and raised, and the scapula is lifted with it. The ribs from the second rib down and from the costal cartilages to the tubercles are removed, along with the intercostal muscles and the pleura. This is accomplished by cutting with bone-shears and scissors. Hemorrhage is arrested. The pleura is curetted. A drainage-tube or a piece of iodoform gauze is introduced, and the raw flap is laid against the visceral layer of the pleura. The superficial incision is sutured, except at the point where the tube or the gauze emerges.

Pneumotomy for Abscess of the Lung.—The instruments required are scalpels, hemostatic forceps, dissecting-forceps, a dry dissector, retractors, a periosteum-elevator, a metacarpal saw, scissors, needles (curved and straight), and a Paquelin cautery.

Operation.—Place the patient recumbent with the shoulders a little raised. Make a U-shaped flap over the seat of disease. If the intercostal spaces are wide, cut down in a space to the pleura. If they are not wide, resect a rib. If it is found that adhesions do not exist between the pulmonary and costal layers of the pleura, stitch these layers together with catgut and postpone further operation for forty-eight hours. If adhesions exist, proceed at once. Incise the agglutinated layers of the pleura, and pass an aspirating-needle into the lung in various directions. When the abscess is located open it with the cautery. Carry the Paquelin cautery slowly into the lung in the direction of the abscess-cavity. The cautery-knife should be at a dull-red heat.

Fowler calls attention to the fact that lung-tissue is so insensitive that the administration of ether can be suspended as soon as the pleura has been opened. When the cautery opens the cavity of the abscess withdraw the instrument and insert a drainage-tube or a bit of iodoform gauze, and suture the flap of superficial tissue. If the abscess is not found after one or two punctures with the aspirating-needle, abandon the attempt.

Tuffier explores for an abscess by what he calls décollement of the parietal pleura. He exposes the parietal layer of the pleura, passes his hand between this layer and the chest-wall, strips the pleura off over a considerable area, and is able to feel the lung below and thus determine its condition.

XXVI. DISEASES AND INJURIES OF THE UPPER DIGESTIVE TRACT.

Diseases of the Mouth, Tongue, and Esophagus.—Harelip and Cleft Palate.—*Harelip* is a congenital cleft in the upper lip due to defective development. *Cleft palate* is a congenital fissure in the soft palate or in both the hard and soft palates. In harelip the cleft is usually complete, through the entire lip into the nostril, but in rare cases it may only show as a furrow in the mucous edge or as a split from the nostril partly into the lip. It is most common on the left side. In double harelip the central portion of the lip is often adherent to the tip of the nose. Double harelip may be free from complication, but is often associated with a malformation of the alveolus and palate. Median harelip is exceedingly rare. In cleft palate the septum of the nose is usually adherent to the palatine process opposite the side upon which the fissure exists. In those rare cases of cleft palate double in front the nasal septum is attached only to the premaxillary bone, and the premaxillary bone is not attached at all to the superior maxillæ. In harelip there is often a cleft in the alveolus, and almost always flattening of the corresponding side of the nose. Harelip is often associated with cleft palate, talipes, and other deformities. It is a great deformity, and interferes with sucking, swallowing, and articulation.

Operation for harelip should be performed between the third and sixth months of life in a child in good health, free from stomach trouble, cough, or coryza, but operation is not advisable in the early weeks of life. Always, if possible, operate before dentition begins (seventh month). If the child is in poor health, postpone the operation until restoration has so far advanced as to render operation safe. While waiting for operation be sure the child is getting enough food. If it cannot suck, feed it with a spoon. If a cleft exists in the palate, operate first upon the lip, because the pressure of the parts after the edges of the gap are approximated aids in the closure of the bony cleft. Cleft palate interferes with sucking, deglutition, mastication, and articulation. In severe cases the food passes into the nose and excites inflammation. Loss of control of the palate-muscles always exists, and liquids and solids are liable to pass into the windpipe. Clefts in the hard palate should not be operated on until the second year, but should be operated upon then, otherwise speech will be permanently affected. Some

surgeons refuse to operate until the tenth or twelfth year, but operation done this late will not correct speech-defect (Edmund Owen). The patient at the period of operation should be well and free from cough. In many cases the passage of food and drink into the nose can largely be prevented by the use of a diaphragm.

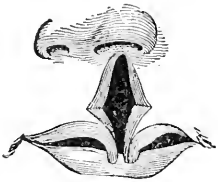


FIG. 256.—Malgaigne's operation for harelip.

Operation for Harelip.—The instruments required are a tenotome and scalpel, toothed forceps, hemostatic forceps, scissors curved on the flat and pointed, straight blunt-pointed scissors, needles (straight and curved), silver wire or silkworm-gut and silk sutures, a mouth-gag and tongue-forceps, a needle-holder, and sequestrum-forceps, each blade protected by a rubber tube. Wrap the child in a sheet; place it in the Trendelenburg position, and rest the head upon a sand-pillow. The surgeon stands to the right side of the patient. Ether or chloroform is given. For single harelip, separate with the scissors the upper lip from the bone on each side of the cleft until approximation of the cleft can be effected without tension. If the maxillary bone of one side projects more than its fellow, grasp it with sequestrum-forceps and bend it back (Jacobson and Treves). Clamp the upper lip at each angle of the mouth to prevent hemorrhage. If the edges are of equal or nearly equal length, and if the gap is not very wide, perform Malgaigne's operation. This is performed as follows: a flap is detached on each side, the detachment beginning at the upper angle of the gap; each flap is detached above but remains attached below. The flaps are separated from the bone, and are drawn downward so as to form a prominence at the vermilion border (Fig. 256). If the edges are pared so that in closure the vermilion border is even, when the parts are healed a gutter will be visible at the line of union. The edges are approximated by an assistant, and silkworm-gut sutures or silver wires are passed by means of a straight needle. Each suture goes down to the mucous membrane. The first suture is passed through the middle of the lip, one-third of an inch from the cleft. Three or four main sutures are passed through the thickness of the lip, and are tied and cut off. Two or three fine silk or catgut sutures are passed by a curved needle through the vermilion border of the lip and the mucous membrane of the mouth, and are tied and cut off. A small piece of gauze is placed over the lip and is held

in place by straps of rubber plaster. After operation prevent the child crying by feeding it often and giving it small doses of laudanum. Heath orders two drops of laudanum in one ounce of distilled water, a teaspoonful to be given every two or three hours. About the sixth day one-half the sutures are taken out, and on the eighth or ninth day the remaining ones are removed. In many cases no further procedure is necessary, but if after some weeks the prominence at the lip-border does not shrink, it can be readily clipped away. Harelip-pins are not used at the present time, and are not needed if the lip is well separated from the bone. If the edges of the cleft are of unequal length, Edmund Owen's operation can be performed (see below, under Double Harelip), or we can perform Mirault's operation, as shown in Fig. 258.

In double harelip the operation is similar to that for single harelip. If the intervening piece is vertical and is covered with healthy skin, complete each operation as for single harelip, closing both fissures at once with silver wire in a strong, healthy child, closing them at intervals of three weeks in one not so lusty (Fig. 257). Excise the septum if it is deformed. The premaxillary bone should in most instances be removed,

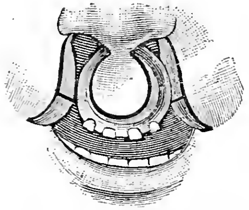


FIG. 257.—Incisions for double harelip (Esmarch and Kowalzig).

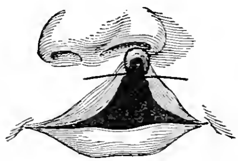


FIG. 258.—Mirault's operation for single harelip (Esmarch).

the skin over it being preserved. Sir Wm. Fergusson was accustomed to incise the mucous membrane and shell out this bone. The premaxillary bone can be forced back into line, being held, if necessary, by catgut suture of the periosteum; but if saved it is liable to necrose and its teeth soon decay. Heath removes this bone two weeks before operating on the lip. If there is much hemorrhage after removal of the bone, arrest it with a hot wire or with Horsley's wax. Fig. 257 shows incisions for double harelip. Edmund Owen's operation is very useful (Figs. 259, 260). In this operation very thick flaps are cut. The prolabium and incisive bone are removed. The flaps are cut as shown, Fig. 259, on one side by line *ab*, and on the other side by line *cde*. *a* is

brought to *c*, *b* is brought to *d*, *f* is brought to *c*, and sutures are applied (Fig. 260).

Operation for Cleft Palate.—It is true that during the early years of growth a cleft diminishes in size; but to wait too long before we operate means permanent speech-impairment. Bony clefts should be operated upon during the second year. Clefts of the soft palate only may be operated

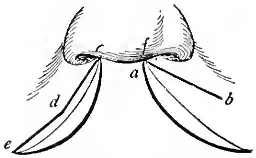


FIG. 259.—Double harelip, the prolabium and incisive bone having been removed (Owen).

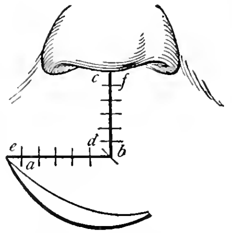


FIG. 260.—The two sides of the lip drawn together and secured by sutures (Owen).

upon during the first six months. If both the hard and soft palates are cleft, close both at one operation. Edmund Owen has recently put forth a convincing plea for early operation.[1] He says he is operating earlier and earlier, and quotes Chilton as the gentleman who led him to do so. Owen maintains that if speech is to be improved operation must be done early, and he formulates some very valuable rules of preparation and care: Have the child in the best condition, free from cough and stomach disorder. Operate in the summer. Place the child under the charge of a nurse several days before the operation. For *suture of the soft palate* (*staphylorrhaphy*) Treves says the following instruments are essential: two sharp-pointed tenotomes, a blunt-pointed tenotome, a rectanglar knife, two pairs of long forceps (one with tenaculum points, one serrated), a fine hook, a pair of sharp-pointed curved scissors, scissors curved on the flat, periosteum-elevators, two long-handled needles with eyes at their points, a suture-catcher, a tubular needle for wire sutures, hemostatic forceps, Whitehead's gag and retractors, silver wire, silkworm-gut, and sponge-holders; also an electric forehead-light. The patient's body may be raised, with his head elevated and rested upon a sand-bag. A better position is that of Trendelenburg, as it prevents the trickling of blood into the windpipe. Chloroform is given. The gag is introduced; the edges of the mucous membrane are pared with a tenotome; the sutures are introduced from below upward, silkworm-gut being used for the uvula and lower part

[1] *Lancet*, Jan. 4, 1896.

of the velum, silver wire for the remainder of the cleft; each suture, as it is passed, is tied or twisted, but is not cut until the next suture is inserted, and serves as a handle. If there is too much tension to allow of the sutures being tied as they are inserted, all the sutures are passed and loosely twisted. A longitudinal incision is made upon each side, internal to the hamular process, the mucous membrane being cut with a sharp tenotome, the deeper structures being divided with a blunt tenotome; the sutures are tied or twisted and cut (Fig. 261). In *Fergusson's operation* for cleft of the hard palate (*uranoplasty*) the mucous edges are pared and the sutures inserted but not tied. Make an incision upon each side down to the bone, the incision being midway between the cleft and the alveolus. Divide the bone on each side, by means of a chisel, to the full length of the incision, and, using the chisel as a lever, force each half of the bone toward the gap. Tie the sutures, and plug each lateral incision with a piece of iodoform gauze (Fig. 262). After the operation for cleft palate put the patient to bed for one week; forbid talking; give fluid or semisolid food at intervals of two or three hours for three weeks; wash out the mouth very

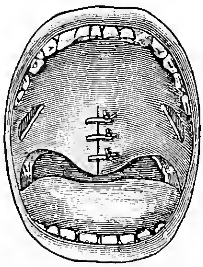


FIG. 261.—Staphylorrhaphy (Esmarch and Kowalzig).

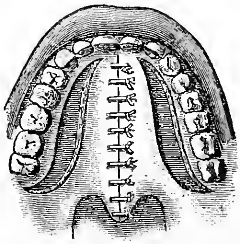


FIG. 262.—Uranoplasty (Esmarch and Kowalzig).

often (always after eating) with a carbolic solution (1 : 100), a solution of boric acid, or Condy's fluid. Sutures are removed in from two to three weeks.

Edmund Owen[1] operates as follows: pare a strip of mucous membrane from each side of the fissure from the tip of the uvula to the top of the gap. Make a free incision "along the alveolar aspect of the palate" close to the teeth. Lift up the strips of mucoperiosteum and shift them toward the cleft. Sever the attachments of the soft palate to the posterior border of the hard palate and extend the alveolar

[1] *Lancet*, Jan. 4, 1896.

incision well backward. This incision relieves tension. Sew up with wire; twist and cut each wire, leaving an end one-eighth of an inch long. This procedure causes the child to keep his tongue from the suture-line. For the first twenty-four hours give only water, and after this period feed with beef-jelly and liquids.

When feeding is begun attempt irrigation or spraying if it does not alarm the child, In a day or two the patient can take sweetened orange-juice, custard-pudding, finely sieved meat or chicken. The best fluid for irrigation is Condy's fluid or mild carbolic acid.

Get the child out in the air a day or two after the operation and keep it out all day. (The entire article of Mr. Owen will well repay a careful reading.)

Carcinoma of the Lower Lip.—Cancer commonly arises in the lower lip, very rarely in the upper lip. Males suffer

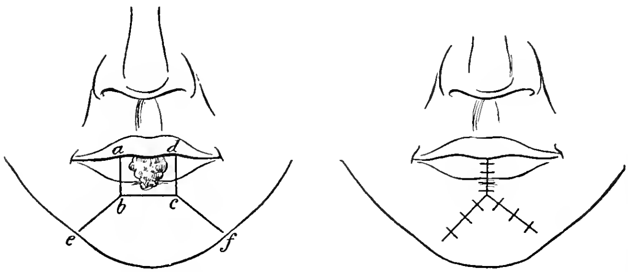


Fig. 263.—Grant's operation for carcinoma of the lip.

frequently, but females are not very often attacked. In some cases it seems to arise in smokers at the point on the lip where the pipe habitually rested. A short-stemmed clay pipe, which grows hot when it is smoked, is particularly apt to lead to the growth of cancer. The region in the lip which is most liable to cancer is the junction of the skin and mucous membrane. The growth may begin in a fissure or abrasion, may start in an eczematous area, but most frequently arises as an indurated area which quickly ulcerates. After a cancer has existed for a variable time the submental and submaxillary lymphatic glands become diseased. This involvement cannot be detected by external manipulation in the earliest stages; hence it is not proper to conclude that glandular involvement is absent simply because it cannot be palpated. It occasionally happens that glands enlarge because of septic absorption, and this enlargement may even precede carcinomatous involvement. From an operative point of view

the glands should always be regarded as carcinomatous. If cancer is not operated upon, it destroys the lip, involves the glands of the neck extensively, the floor of the mouth, the periosteum and lower jaw, and produces death in from three to five years. If the jaw is involved, the prognosis is bad, and it is practically hopeless if the floor of the mouth is involved.

Treatment.—The treatment consists in the early and thorough removal of the growth with the knife, and also in the removal of the fatty tissue and glands from the submaxillary triangle and from the submental region. The growth must be thoroughly removed, that is, the incision must be at least half an inch wide of the disease. Thorough early removal will cure about 50 per cent. of cases. For many years a favorite operation has been the V-shaped incision, the skin-edges being sutured by silkworm-gut, the sutures being passed almost to the mucous membrane and being inserted so as to compress the vessels when tied, and the mucous membrane being sutured with fine silk or catgut. The V-shaped incision should only be used for a small growth. After the removal of the growth from the lip a vertical incision is made from the point of the V over the cricoid cartilage, and from the origin of this incision incisions are made in each direction along the under surface of the body of the

FIG. 264.—Removal of lower lip and cheiloplasty (Esmarch and Kowalzig).

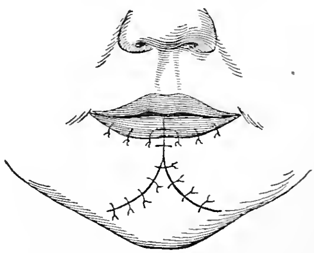


FIG. 265.—Suturing in cheiloplasty (Esmarch and Kowalzig).

jaw. The glandular area is thus exposed, and after the removal of the fat and glands the wound is sutured with silkworm-gut. Better than the V-shaped incision is the method devised by W. W. Grant of Denver.[1] In this operation the growth is removed and cheiloplasty is performed. This operation secures a larger, less rigid, and more useful lip than does the older method. In this operation the growth is removed by two perpendicular incisions and a transverse cut (Fig. 263).

[1] *Medical Record*, May 27, 1899.

From each lower angle of the wound an oblique incision, is made (Fig. 263, *b c*, *c f*), and these incisions, if carried below the jaw, permit the removal of lymph-glands. The flaps are sutured as shown in Fig. 263.

In a case in which the lip is extensively involved the entire lip should be removed and a new lip should be taken from sound tissue and fastened in place. This operation is shown in Figs. 264 and 265.

Tongue-tie is a congenital shortness of the frenum. The tongue cannot be protruded beyond the incisor teeth. Swallowing is interfered with, and later in life articulation is impeded. Treat tongue-tie by tearing up the frenum with the thumb-nail. If this fails, catch the frenum in the slit in the handle of a grooved director, push the director toward the base of the tongue, and knick the frenum with scissors curved on the flat and pointed toward the floor of the mouth. The frenum should be knicked nearer the floor of the mouth than to the tongue.

Ranula is a retention-cyst of the duct of the submaxillary or the duct of the sublingual gland. A ranula when first formed contains saliva, but after a time the saliva undergoes a change, and in appearance comes to resemble mucus. Mucous cysts occur in the floor of the mouth, resulting from obstruction of the ducts of the mucous glands of Nuhn and Blandin. These glands lie on each side of the frenum of the tongue. Such a cyst is often spoken of as a ranula. A ranula appears upon the floor of the mouth on one side and pushes the tongue toward the opposite side. The contents of a ranula resemble mucus or saliva. The *treatment* of a mucous cyst is by excision of a portion of the cyst-wall and cauterization of the interior with pure carbolic acid; or by cutting a flap from the cyst-wall and stitching it aside so as to keep a permanent opening. Such an operation may cure a genuine ranula, but will often fail. In true ranula an external incision should be made, and through this both the cyst and the gland should be removed. This plan is recommended by Mintz.[1]

Carcinoma of the Tongue.—This is one of the most dreadful forms of cancer. It is quite a common disease. It begins, as a rule, near the tip, on the side or at the base of the anterior two-thirds of the tongue, as an ulcer having at first a papillary structure, as a fissure which indurates, or as an indurated area which ulcerates. The cause of the growth may sometimes be traced to the irritation of a jagged tooth, or to the smoking of a pipe, or to holding nails in the mouth,

[1] *Zeitschrift für Chirurgie*, March, 1899.

as is done by those who nail laths. Cancer may follow a chronic inflammation—leukoplakia, for instance. As in cancer of the lip, men are much more frequently affected than women. In most cases the disease spreads rapidly; produces early and extensive glandular involvement; disease of the floor of the mouth; dribbling of saliva; difficulty in masticating, swallowing, and talking; foulness of the breath; severe pain which usually radiates toward the ear, and often a fatal septic trouble. Cases not operated upon usually die within two years. There is a very rare form of carcinoma described by Wölfler, which grows very slowly or even remains latent for years.

One reason why cancer of the tongue grows so rapidly has been pointed out by Heidenhain of Greifswald. The lingual muscles are contracting almost constantly, and as a result cancer-cells are forced along the lymph-spaces to healthy areas.

Treatment.—A cancer of the tongue should be removed radically at the earliest possible moment. Before any operation is undertaken all stumps of teeth should be removed. For several days before an operation the teeth should be scrubbed twice a day with a brush and soap, and the mouth, nares, and nasopharynx should be sprayed with peroxid of hydrogen and then with boric-acid solution every second or third hour when the patient is awake.

In this disease not only the tongue, but also the adjacent lymphatic glands must be removed. The lymph-vessels from the tongue pass to the submaxillary and deep cervical lymphatic glands.

In a very recent and limited case only the glands on the diseased side require removal; in an advanced case the glands must be removed from *both sides* of the neck, because it has been shown by Kuttner of Tubingen that lymph from one side of the tongue may flow to glands on the same side of the neck; but some also may flow to the opposite side of the tongue. Two operations are to be considered: partial removal and complete removal.

Partial Removal of the Tongue.—This operation is restricted to recent cases in which one side only of the anterior portion of the tongue is involved. The operation does not offer as good a chance of cure as complete excision, because lymph containing cancer-cells may have reached the opposite side of the tongue. In partial removal the glands must be removed from the side which is diseased. If the case is sufficiently advanced to require removal of the

glands from both sides of the neck, the tongue should be completely removed.

In performing the operation of partial excision introduce a mouth-gag, place a silk ligature on each half of the tip of the tongue, and draw the tongue out of the mouth (Barker). Place the patient in the Trendelenburg position. Split the tongue back in the middle line with the scissors, and loosen the cancerous side from the floor and side of the mouth. Pass a stout silk ligature through the base of the tongue posterior to the cancer. Draw the organ out and cut off the diseased side in front of the ligature but back of the disease. Tie the vessels, remove the constricting and traction threads, and treat subsequently as in cases of complete removal.

Complete Removal of the Tongue (Kocher's Method).—Kocher used to employ a preliminary tracheotomy in tongue-excision, but the Trendelenburg position renders this procedure unnecessary so far as fear of the passage of blood into the larynx and trachea is concerned. The instruments required are a scalpel, retractors, a dry dissector, hemostatic and dissecting-forceps, a tenaculum, aneurysm-needle, tenaculum-forceps, needles, sutures, and scissors. In this operation the patient is placed in the Trendelenburg position, the surgeon standing to the affected side. Chloroform is given. Ligate the lingual artery on the side opposite to the one where the main incision is to be made. Remove the glands on that side and suture the wound. An incision is then made on the side opposite to that on which the artery was ligated. This incision passes from behind the lobe of the ear, along the anterior edge of the sternocleidomastoid to about the middle of the margin of this muscle. From this point the incision is carried to the level of the hyoid bone and then to the symphysis menti, along the anterior belly of the digastric muscle (Fig. 266). The flap is dissected and turned up; the facial and lingual arteries are ligated; "the submaxillary fossa is evacuated" (Treves); the sublingual and submaxillary glands are removed; the mylohyoid muscle is divided; the mucous membrane is incised close to the jaw, and the tongue, caught with

Fig. 266.—Kocher's excision of tongue (Esmarch and Kowalzig).

tenaculum-forceps, is drawn through the opening. The tongue is split in the middle with scissors, and the near half is removed, bleeding is arrested, the remaining half of the tongue is cut through, and the vessels are tied. Stitch the mucous membrane of the stump to the mucous membrane of the floor of the mouth with catgut sutures. Kocher does not suture the skin-wound; many surgeons do suture it and employ drainage-tubes. Some hours after the operation, when oozing has ceased, dust the mouth-wound with iodoform. The patient, as soon as possible, is propped up in bed, and he must not swallow the discharges if it can be avoided. The mouth, every half hour, is sprayed with peroxid of hydrogen and washed with a carbolic solution (1 : 60). Every three hours after washing the floor of the mouth and the stump the parts should be dried with absorbent cotton and dusted with iodoform. For twenty-four hours after the operation nothing is given by the mouth except a little cracked ice, the patient being fed per rectum. At the end of twenty-four or forty-eight hours some liquid food is given from a feeding-cup. The patient will soon learn to swallow; but if he cannot swallow easily, he is fed with a tube. Treves, in his clear and positive directions for after-treatment, states that nutrient enemata are to be continued until sufficient nourishment is taken by the mouth; that the mouth should be flushed by irrigation, and must be washed immediately after taking food; that morphin is to be avoided; and that the patient can usually leave the hospital in from seven to ten days.

Whitehead's Operation.—Whitehead removes the entire tongue from within the mouth by the use of scissors. He passes a ligature through the tip, cuts the frenum, draws the tongue strongly forward, and separates by a series of clips with the scissors. The lingual arteries are tied as cut. "The stump should be kept under control, as regards hemorrhage, by a stout silk ligature passed through the remains of the glosso-epiglottidean fold and retained for twenty-four hours."[1]

Heath has shown that if the forefinger be passed to the epiglottis and used to "hook forward" the hyoid bone, the lingual arteries are stretched and portions of the tongue can be removed almost without bleeding. It is rarely desirable, except in Kocher's operation, to remove the glands and the tongue at one séance. To do so increases shock and the danger of death. The rule of procedure set forth by W. Watson Cheyne[2] is eminently wise. This rule is as follows:

[1] *American Text-book of Surgery.* [2] *The Practitioner*, April, 1899.

If glandular involvement is trivial or not detectable, it is perfectly proper to remove the tongue first, and after a week or so remove the glands. If the glandular involvement is marked, growth in the glands will be much more rapid than growth in the tongue. In such a case the glands should be removed before the tongue, because, if the tongue is removed before the triangles are cleared, in the week or two of waiting the case may become inoperable. In the majority of cases clear out the triangles before removing the tongue, doing the other operation in one or two weeks when the wound in the neck is healed. If the disease in the mouth is far advanced, do both operations at one séance.

Stricture of the Esophagus.—*Fibrous* or *cicatricial* stricture is due to the healing of an ulcer, and results from traumatism, chronic inflammation, syphilis, tuberculosis, chronic ulcer, prolonged vomiting, variola, gout, or to swallowing a corrosive substance or a boiling liquid. It is commonest in the young, and is apt to be situated opposite the cricoid cartilage, at the tracheal bifurcation or near the cardiac end. Cicatricial strictures are usually single, but may be multiple. Stricture following impaction of a foreign body is located at the seat of impaction unless the tube has been injured by efforts at extraction, in which case multiple strictures may exist (Maylard). Strictures which result from swallowing boiling fluid or corrosive liquid are usually very extensive, and may be multiple. Syphilitic stenosis is due to the healing of a gummatous ulceration, but there is nothing characteristic in this kind of stenosis. Tubercular stenosis is extremely rare.

Symptoms of Cicatricial Stenosis.—The condition may occur at any age. The chief symptom is difficulty in swallowing, at first slight, but becoming more and more pronounced until swallowing is almost or quite impossible. The dysphagia is first manifested to dry solids, then to all solids, and finally to liquids. In some cases vomiting occurs after swallowing. If the stricture is high up, the vomiting is almost immediate; if it is low down, the vomiting is delayed, especially if the canal is dilated above the stricture. From time to time the patient vomits independently of taking food, the ejected matter being saliva. The vomited matter is not bloody. The patient feels weak and hungry, becomes exhausted and emaciated, and suffers from flatulence, gastralgia, and constipation.

There is occasionally slight uneasiness or even pain in the region of the stricture, possibly "about the epigastrium or

between the shoulder-blades" (Maylard). The stricture may be located with a bougie. The history of the case is of much importance in diagnosis. The surgeon must inquire about impaction of a foreign body, or swallowing of acids, alkalies, or boiling fluids; and must examine for evidence of syphilis. If there is no history of injury or syphilis, and the patient is over forty years of age, the indications point to cancer rather than cicatricial stenosis. The easy passage of a bougie when the patient is anesthetized shows that spasm is the cause, and not organic disease. Narrowing due to ex-

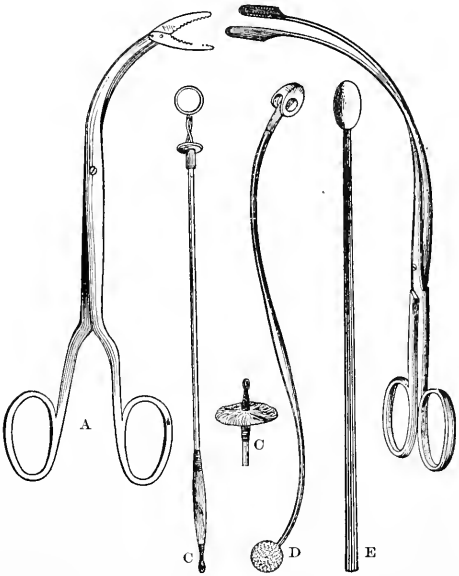


FIG. 267.—Esophageal instruments: A, B, forceps; C, horsehair probang; D, coin-catcher; E, esophageal bougie.

ternal pressure is marked by positive symptoms of the causative disease.[1]

Treatment.—Gradual dilatation through the mouth is a method employed for at least a time in almost every case. Begin with the largest bougie which will easily pass. Warm the bougie, oil it, pass it gently, and hold it in position for several minutes, prolonging the time of retention of the bougie as treatment progresses. Pass an instrument every second or third day, gradually increasing the size. If the

See the excellent article in Maylard's *Surgery of the Alimentary Canal.*

stenosis involves a considerable portion of the esophagus, gradual dilatation will almost certainly fail to cure.

Symonds advocates the insertion of a tube through the stricture and leaving it in place until there is decided dilatation, and then replacing the tube with a larger instrument. The patient is fed through the tube. Gradual dilatation from below has been practised in cases where a bougie could not be passed from the mouth. A gastrostomy is performed, and after the fistula has become sound the patient is made to swallow "a shot to which is attached a silk thread" (Maylard). The silk thread is brought out through the fistulous orifice and is attached to a bougie, and the dilating instrument is pulled up through the esophagus. Forcible dilatation can be employed through the mouth or through a gastrotomy opening by means of bougies, tents, or divulsing instruments. Electrolysis is used by Fort and others. Some surgeons perform internal esophagotomy through the mouth with a special instrument. A fibrous stenosis in the region of the cricoid cartilage should be treated by the operation of external esophagotomy. In this operation the stricture is divided by a longitudinal incision; "funnel-shaped retraction of the cut portion is caused by adhesion to the external tissues divided, and it lessens future contraction."[1] If dilatation fails in the case of a stenosis above the line of the aortic arch, the esophagus is opened above the stricture (external esophagotomy), a tenotome is introduced through the wound, the stricture is cut and well dilated by the passage of instruments. This operation is known as Gussenbauer's combined esophagotomy.

If a stricture is impassable from above, the stomach should be opened and retrograde dilatation be carried out. A firm, non-dilatable stricture in the thoracic portion of the esophagus can be treated by Abbe's method. He performs a gastrotomy, passes a conical rubber bougie from the stomach into the mouth, ties a piece of braided silk to the bougie, withdraws the instrument and leaves the silk in place. One end of the silk emerges from the mouth and the other end from the gastrotomy wound. In some cases he opens the stomach and also opens the esophagus above the stricture; one end of the string comes out of the esophagotomy wound and the other end out of the gastrotomy wound. The string is used as a string- or bow-saw, the stricture is divided, the silk is with-

[1] W. J. Mayo, *Journal American Medical Association*, July 29, 1899.

drawn, full-sized bougies are passed, and the wound or wounds are sutured.

Ochsner's operation is thus described by Mayo:[1] "The anterior wall of the stomach is drawn out of a left oblique incision through the abdominal coverings; a small opening is made into the stomach sufficient in size to introduce the finger. A whalebone probe, to the tip of which a silk string guide has been tied, is now passed through the esophagus either from above or retrograde, as in the Abbe method. With this guide a loop of silk is drawn out of the gastric incision in such manner as to leave the guide as a third string. Into this loop a small soft-rubber drainage-tube three feet or more in length is caught in the middle by traction on the ends of the doubled thread through the mouth; this loop of rubber tube is drawn through the stomach and made to engage in the stricture.

"The greater the amount of traction the smaller the stretched rubber tube, until it is sufficiently reduced in size to enter the stenosed portion; by alternating the direction of the pull the tube is drawn out by its free ends and in by the silk loop. Increasing sizes of tubes can be employed, and if necessary the third string can be used as a string-saw after the Abbe plan of procedure. This operation was first successfully performed by Dr. A. J. Ochsner of Chicago." In a very severe case of stenosis gastrostomy is performed to keep the patient from starving.

Cancer of the Esophagus.—This disease causes obstruction of the esophagus. It arises in those beyond middle life, and is far more common in men than in women. The disease may arise at any portion of the gullet, but is least often met with in the central portion (Maylard, Butlin). Epithelioma is the usual form, but scirrhus or encephaloid may occur. Cancer soon ulcerates, involves adjacent parts, and affects the deep cervical and posterior mediastinal glands.

Symptoms of Cancerous Stenosis.—The patient is over forty years of age, is usually a male, and presents the same difficulty of swallowing met with in cicatricial stenosis. The vomited matter is apt to contain blood, the use of the bougie causes bleeding; there are generally decided pain and very great emaciation. The seat of obstruction is located by the bougie and by listening over the spine while the patient is attempting to swallow water. The stomach is the seat of pain; the mouth is dry and there is often great thirst. As the

[1] *Journal American Medical Association*, July 29, 1899.

disease infiltrates the involvement of adjacent regions produces other symptoms. Dyspnea may result from tracheal pressure. Pleuritis, pericarditis, or pneumonia may arise.

Treatment.—The disease is of necessity fatal, and treatment is only palliative. Successful incision is not feasible. The patient should be put upon a soft, bland diet in small quantities given frequently. When trouble is experienced even with such food pass a bougie every third or fourth day. When the patient becomes entirely unable to swallow soft food we may insert a Symonds tube or do an esophagostomy (if this can be performed below the stricture), or perform gastrostomy. In every doubtful case of esophageal stricture give a course of iodid of potassium before performing any operation.

Spasmodic Stricture of the Esophagus (Esophagismus, Hysterical Stricture).—By this term is meant a spasm of the circular muscular fibers of the gullet, which is most common at one end of the tube. This condition not unusually arises in a hysterical individual, in which case it will be associated with the stigmata of hysteria, especially globus hystericus. In some cases evidences of hysteria are wanting, although the patient is neurotic, and the condition is due to a reflex irritation. It has arisen in cases of cancer of the stomach, cancer of the liver, ulceration of the larynx, and during pregnancy. It occasionally occurs in tetanus, always in hydrophobia, and sometimes in epilepsy.

Symptoms of Spasmodic Stenosis.—It arises suddenly in a hysterical or neurotic individual. It may last for a time and suddenly pass away, or may persist for a long time. The difficulty in swallowing is irregular; sometimes solids are taken more readily than fluids, and *vice versa.*

There may be regurgitation; but if it occurs, it does so at once on swallowing food. Examination with a bougie detects the obstruction. If the bougie is held firmly against it, in most cases the spasm will, after a time, relax and let the instrument pass. A medium-sized instrument or a large instrument can be passed more easily than a small one. In some cases no instrument can be passed until the patient has been anesthetized, but in every case a bougie can be passed after an anesthetic has been given.

Treatment.—The systematic passage of bougies. Occasionally the passage of an instrument but once will cure a case. The general health must be improved, and in persistent cases it may be necessary to use electricity within the esophagus, employ cold locally, and administer the bromides.

Diverticula of the Esophagus.—Maylard tells us that these pouches may be due to one of four causes—they may be congenital; may be due to stricture; may be caused by pressure from within, upon a weak spot of the wall; may be due to traction from without, by the healing and contraction of an area of inflammation.

Symptoms.—When the diverticulum is in the neck a lump forms during deglutition, and this lump may be obliterated by pressure. Food will pass into the stomach only when the diverticulum is full. A bougie cannot be passed unless the pouch is full of food, at which time it may pass or may not. This latter symptom, the variability in the passage of the bougie, is the evidence relied on for diagnosis in intrathoracic diverticula. By listening with a stethoscope fluid may be heard to pass into the pouch. After a patient swallows food mixed with subnitrate of bismuth a diverticulum may be skiagraphed.

Treatment.—Extirpation and suture, as performed by von Bergmann, Hearn, and others.

Injuries of the Esophagus.—Injuries of the internal surface are more common than injuries from without. Burns and scalds are among these injuries. Wounds may be inflicted by foreign bodies. These injuries cause pain on swallowing. A severe injury causes bleeding, the blood being both coughed up and vomited. A severe wound may involve a large vessel and cause violent or fatal hemorrhage. If the bronchus or trachea is involved, there will be "cough and expectoration of blood, mucus, and food" (Maylard). The pleural or pericardiac sacs may be perforated.

Treatment.—Feed only by the rectum. Give morphin hypodermatically. Do not feed by the mouth for ten days, and even then give only fluid food and jelly. Symptoms are met as they arise. After burns by caustic, administer the antidote; give large draughts of water and wash out the stomach. From two to four weeks after a caustic has been swallowed and after a burn or scald, the use of sounds should be begun, and sounding should be persisted in for a considerable time to prevent contraction.

Injuries of the Esophagus from Outside, without Involvement of Other Structures.—Such injuries are rare. Esophageal injuries, as a rule, are associated with serious damage to adjacent structures. These injuries may be due to stabs or to bullets. Besides the obvious external signs of the injury there will be difficulty in swallowing, cough, bloody expectoration or vomiting; and mucus or the contents of the stomach may run out of the wound.

Treatment.—Suture the wound, and feed by the rectum for ten days.

Foreign Bodies Lodged in the Esophagus.—These accidents occur especially to children and lunatics, and women are more apt to suffer from them than are men. An extended list of bodies which have been swallowed will be found in Poulet's elaborate treatise. There are three regions where a foreign body is especially apt to lodge—viz. opposite the cricoid cartilage, at the level of the diaphragm, and at the point where the left bronchus crosses the gullet. Small and sharp bodies may lodge anywhere.

Symptoms.—The symptoms are variable; if the body is large, there will be pain and difficulty in swallowing, and, in some cases, dyspnea from pressure upon the trachea or bronchus. Death may result from asphyxia. In some other cases the symptoms are very slight. If the body is sharp, there will be hemorrhage and severe pain. The blood may be hawked up, or may be swallowed and vomited. A patient may grow accustomed to a foreign body and cease to notice it; but, on the contrary, the foreign body may produce inflammation, and even may ulcerate into the windpipe, the pleura, the pericardium, or the aorta. In many cases of impaction a patient makes violent efforts to hawk it up, and produces aphonia. There may be violent retching. Even after a foreign body has been removed by swallowing or otherwise a sensation is apt to remain as if it were still lodged. The diagnosis is made by the history, the detection of the body by external manipulation, by feeling it with an esophageal bougie, and, if bone or metal, seeing it with the fluoroscope or obtaining a skiagraph.

Treatment.—The surgeon should find out if possible the size, shape, weight, and nature of the foreign body, and locate its point of impaction. The exact point of lodgement of bone or a metallic body is determined by the *x*-rays.[1] An anesthetic is usually necessary for a child, a nervous woman, or a lunatic, and is *sometimes* necessary for a man. If the foreign body is soft, external manipulation may succeed in altering its shape, so that it may be swallowed or ejected. If the foreign body is hard, external manipulation may shift its position. It is usually impossible to reach the foreign body through the mouth by means of the fingers (when the body is in the rear of the pharynx it may be pulled forward or pushed down). Sharp foreign bodies may be entangled and carried down when the patient eats mush, bread, or boiled

[1] See cases of White, Keen, Alfred Wood, MacIntyre, Taylor, and others.

potatoes. The administration of emetics is an old plan which occasionally succeeds, but which is too unsafe to be employed. Maylard says that when a mass of food is impacted it is occasionally possible to soften and disintegrate the mass by administering a mixture containing pepsin. The horsehair probang is a very useful instrument (Fig. 267, C). It may be used to push a body downward into the stomach, or to catch the body and pull it up. When this instrument is withdrawn it opens like an umbrella. Morris Richardson has shown that in an adult the diaphragmatic opening is about fourteen and one-half inches from the incisor teeth, a point to be remembered in deciding whether to push down or pull up the impacted article. Esophageal forceps (Fig. 267, A, B) are valuable in some cases. The coin-catcher (Fig. 267, D) is a useful instrument. Créquy's plan of removal is to take a tangled mass of threads, tie a stout piece of string about the middle of it, coat it with sugar, and have the patient swallow it. It may pass the foreign body; if it does so, on withdrawal it may entangle the object and extract it. To remove a fish-hook with line attached, the following plan may prove successful: stick the line into a metal catheter, carry the catheter down to the hook, and push the hook out. It is not proper to allow a foreign body to remain in the esophagus until it causes ulceration. Neither is it proper to make prolonged efforts to extract it through the mouth. Such efforts may do great harm, and if one careful and consistent effort fails an operation should be performed. If the body is lodged anywhere above the lower third of the esophagus, external esophagotomy is performed, and usually on the left side. Through this wound the foreign body is extracted. The cut is made on the left side, between the trachea and larynx in front and the carotid sheath behind, the center of the incision being opposite the cricoid cartilage. After the foreign body is extracted the mucous membrane is sutured with chromic catgut, and the superficial structures are closed with silkworm-gut after a drainage-tube has been inserted. The patient is fed by the rectum for eight or ten days. When a foreign body is lodged in the lower portion of the tube, the stomach is opened and the body extracted by this route (Morris Richardson). In White's case of jackstone in the gullet gastrotomy was performed. A string was tied about some rolls of gauze, the string was passed by means of a whalebone from the stomach into the mouth, and the body was entangled and drawn out.

XXVII. DISEASES AND INJURIES OF THE ABDOMEN.

Contusion of the Abdominal Wall without Injury of Viscera.—In some cases of contusion of the abdominal wall only the parietes are damaged; in other cases the viscera or the abdominal tissues are injured. Contusion may involve the skin alone, or may involve the skin, muscles, and peritoneum. In *simple contusion* there is considerable shock if the injury is severe. There is pain, increased by respiration, motion, pressure, and attempts at urination or defecation. When tenderness appears some days after the accident there is usually deep-seated injury. Extensive ecchymosis may appear. Even after a severe contusing force has been applied there may be no discoloration, and it may happen that after a slight force there is much discoloration. There is great ecchymosis in anemic persons, victims of hemiplegia, in obese individuals, opium-eaters, and drunkards. In severe cases the tissues are pulpefied and sloughing inevitably ensues. Abscess occasionally follows contusion. The prognosis after abdominal contusion is always uncertain.

Treatment of Simple Contusion.—In treating simple contusion place the patient at rest in a supine position, with the thighs flexed over a pillow; obtain reaction from the shock. Give morphin if pain is severe. After shock has passed off it is advisable to place an ice-bag over the seat of injury. If much blood is extravasated, aspirate and apply a binder. After twenty-four hours apply local heat by means of the hot-water bag, employ an ointment of ichthyol, and move the bowels, if necessary, by salines. Regard every contusion as serious, and watch carefully for the development of signs of internal hemorrhage or visceral injury.

Muscular Rupture from Contusion.—In this injury there are severe shock and pain (increased by respiration and movement). Separation between the fibers of the muscle is distinct at first, but it is soon masked by effusion of blood. Such injuries may cause death, or may lead to hernia. The rectus is the muscle most apt to rupture. The rupture is due to sudden contraction rather than to the direct effect of a blow.

The *treatment* is the same as for simple contusion. Always apply a binder. A hernia is returned and a compress is applied over the opening through which it emerged. If strangulation occurs, operate at once.

Injuries with Damage to the Peritoneum or the Viscera.—**Rupture of the Peritoneum.**—The peritoneum

may be involved in an abdominal contusion. It may rupture even when there is no visceral injury or muscular contusion. The uterine peritoneum, the parietal peritoneum, the visceral peritoneum, or the mesentery may rupture. Rupture of the peritoneum causes intra-abdominal hemorrhage.

The *treatment* consists in opening the abdomen, arresting the hemorrhage, and bringing about reaction.

An injury to the peritoneum creates a point of least resistance, and at such a point peritonitis may develop. The peritonitis is usually local, but may become general. After any severe intra-abdominal injury the symptoms of peritoneal shock appear (peritonism), and the patient may rapidly die. In the condition of peritonism the temperature is subnormal; the extremities are cold; the face is pallid and sunken; the pulse is small, weak, and very frequent; the respiration is shallow and sighing; there is great thirst; the patient is restless and tosses about. Vomiting almost always occurs. In some cases there is regurgitation rather than vomiting. The abdomen is the seat of a violent, persistent pain. The patient is fearful of impending death. As the symptoms develop in a grave case they will point to one of two conditions, hemorrhage or peritonitis.

In intra-abdominal hemorrhage the subnormal temperature and other evidences of shock persist. Vomiting ceases, but nausea exists. The patient is uncontrollably restless and tosses about in bed. The thirst is great. The abdomen is not rigid. Fainting-spells occur. Blood-examination shows a marked fall in the percentage of hemoglobin. Percussion demonstrates the existence of an effusion which alters its position as the patient's position is altered, and which gradually increases in amount. Dulness is first met with in the loins. Rectal or vaginal examination may aid in diagnosis. If peritonitis develops, the vomiting becomes worse, the pain intensifies, and the abdomen grows rigid and distended.

Rupture of the Stomach without External Wound.—The usual cause of rupture is a violent blow, although the accident may happen in washing out the stomach. Rupture is more apt to occur when the stomach is distended with food than when it is empty. The rupture may be partial, the peritoneal coat not being torn. The rupture may be complete. The region of the pylorus is most apt to be lacerated. The symptoms of rupture are collapse, severe pain over the entire abdomen, great thirst, excessive tenderness, especially over the epigastric region, occasionally vomiting, the vomited matter being usually, but not invariably, bloody; tympanitic distention and

muscular rigidity coming on after a few hours. Gas may enter the abdominal cavity and cause the disappearance of liver-dulness, but the area of liver-dulness can be lessened by great intestinal distention. After *incomplete* rupture local peritonitis is frequent; in *complete* rupture the escape of food into the peritoneal cavity causes general peritonitis. To diagnosticate between complete and incomplete rupture, endeavor to distend the viscus with hydrogen gas: in incomplete rupture the contour of the dilated stomach can be made out upon the surface; in complete rupture the viscus cannot be distended, and the gas passes into the peritoneal cavity, producing the physical signs of tympanites (Senn).

The *treatment* in complete rupture is as follows: if signs of hemorrhage are absent, endeavor to bring about reaction before operating. If these signs are present, operate at once, and have salt solution infused into a vein during the operation. Open the abdomen. If the seat of rupture is not visible, it may be found by inflating the stomach with hydrogen. Flush out the stomach and the peritoneal cavity with hot salt-solution; sew up the stomach-wound with a double row of silk sutures, the first row being buried and including the muscular coat and mucous coat, the second row being Halsted sutures; drain; close the wound in the parietes with silkworm-gut; feed by the rectum for four days, and then begin the administration of a very little food by the mouth. In incomplete rupture the danger is perforation. The patient is put to bed, and after reaction has taken place, is fed by the rectum for several days, and morphin is given hypodermatically.

Rupture of the Intestine without External Wound.—The symptoms of this injury are profound shock, tympanites, and pain, rapidly followed by peritonitis if the patient survives. Vomiting comes on soon after the accident, the vomited matters being possibly at first bloody and later stercoraceous. The respiration is thoracic, the tongue is dry, and great thirst exists. The pulse, which is slow at first, becomes small and rapid and of high tension. Any portion of the intestine may rupture, but the ileum is most liable to this accident. Blood in the stools rarely appears early enough to be of diagnostic value. The escape of gas into the peritoneal cavity may cause the diminution or disappearance of liver-dulness. After anesthetizing the patient hydrogen gas insufflated into the rectum will come from the mouth if there is no perforation in the stomach or the intestine; if a perforation exists, tympanites is much increased, and the area of liver-dulness disappears. To

apply rectal insufflation of hydrogen, generate the gas in a bottle by means of zinc and sulphuric acid, catch the gas in a large rubber bag, and attach the tube from the gas reservoir to a tip which is inserted in the rectum. Give the patient ether to relax the abdominal muscles, direct an assistant to press the anal margins against the rectal tip, and when the patient is unconscious turn on the stopcock and press upon the reservoir (Senn).

It has been suggested that ether vapor, mixed with air, can be used instead of hydrogen gas.[1] In this method a little ether is poured into the bottle of an aspirator, the valves are opened, one tube is carried into the rectum, the other tube is attached to a bicycle-pump, and by working the pump the ether vapor is driven into the bowel. If there is perforation, tympanites is notably increased. Some surgeons regard the rectal insufflation test as unsatisfactory and often dangerous.

Treatment of Rupture of Intestine.—If symptoms point to dangerous hemorrhage, operate at once; otherwise do not operate until reaction has been obtained. Wrap the patient in blankets, surround him with hot cans, give hot stimulating enemata, give stimulants by the rectum, and a hypodermatic injection of morphin and atropin; infuse hot saline fluid into a vein; asepticize and anesthetize. Perform a laparotomy; check hemorrhage; find the rent, and close it by Halsted sutures if possible. The hydrogen gas test of Senn will locate a perforation. It may be necessary to perform an end-to-end approximation or a lateral anastomosis. Flush the abdominal cavity with hot saline solution, and wipe the peritoneal fossæ and the space between the liver and diaphragm with gauze. Finney eviscerates, wipes out the abdominal cavity, and wipes the intestines as he restores them. Whatever method is used to cleanse the abdomen, remember that infectious material is apt to accumulate between the liver and diaphragm and in Douglas's pouch. Drainage is to be used.

"In abdominal operations it is frequently imperatively necessary that the large intestine be recognized with certainty or the small bowel be positively identified. The size of the tube will not always aid in this recognition, as a small intestine may be distended enormously and a large intestine may be contracted to the size of a finger because of obstruction above. The longitudinal muscular fibers of the large bowel are accentuated in three portions; these accentuations

[1] Emerson M. Sutton of Geneva, in *Jour. Am. Med. Assoc.*, July 23, 1898.

constitute the three longitudinal bands which begin at the cecum and terminate at the end of the sigmoid flexure of the colon. Each band is composed of a number of shorter bands, the shortness of these constituent bands permitting the sacculation of the large intestine. Longitudinal bands and sacculation are not met with in the small gut, their presence or absence being a means of identification in many cases; but when the colon is much distended the bands cannot be seen distinctly and the sacculation disappears. From the large intestine only spring the appendices epiploicæ (small overgrowths of fat in pouches of peritoneum), but they are sometimes not well marked except upon the transverse colon, and when emaciation exists they may almost entirely disappear. The relatively fixed position of the large intestine and the free mobility of the small bowel are important points of distinction. The foregoing indicates that it is not always easy to distinguish between colon and small gut, and that, according to old rules, it may be often necessary to make large incisions, to see as well as feel, and to handle a large extent of the bowel. Any scrap of knowledge that will shorten an abdominal operation, that will permit of as certain work through a smaller incision, and that will diminish handling of intraperitoneal structures, tends to increase the chances of recovery. For these reasons the writer suggests a method of bowel-identification which rests upon the facts that each bowel has a posterior attachment, that the origin of the attachment differs according to the bowel it supports, that a single finger can detect the origin of the peritoneal support of any section of the bowel, and, this origin being known, the portion of the bowel it supports is with certainty deducible. In an exploratory operation, for instance, the finger comes in contact with the bowel: to determine whether it is a large or a small bowel, note first if the structure is movable or is firmly fixed; next, pass the finger over the bowel and let it find its way posteriorly. If dealing with a small bowel, the finger will reach the origin of the mesentery between the left side of the second lumbar vertebra and the right sacro-iliac joint; if dealing with the large bowel, the finger will reach the origin of the mesocolon, or the point where the colon is fixed posteriorly and to the side."[1]

Rupture of the liver may be caused by a blow, a fall from a height, or the concussion of a railroad collision. Occasionally the ends of fractured ribs are driven into the organ.

[1] The author, in *Medical News*, June 9, 1894.

The **symptoms** are those previously set forth as attending severe intra-abdominal injury (p. 761). In addition there are tenderness over the liver, and often pain in the abdomen and back. As a rule, the signs of hemorrhage are present. Sugar may appear in the urine. The respiration is much embarrassed. After a few days the skin may itch and become jaundiced, but this is rare.

In these cases operate at once if hemorrhage is severe; otherwise operate after bringing about reaction. Stop bleeding in the liver by cautery, by suture, or by packing. In a superficial tear introduce sutures of catgut or silk. In a deep tear suture the liver to the belly-wall, pack the wound with gauze, and surround it with gauze.

Rupture of the Gall-bladder and the Bile-ducts.—Rupture of the gall-bladder or the ducts is most apt to happen from injury when gall-stones exist. Peritonitis, general or local, is almost certain to follow such a rupture. Besides those symptoms common to all severe abdominal injuries, there is often intense jaundice.

Treatment.—Suture the laceration or make a biliary fistula.

Rupture of the Spleen.—The spleen may be dislocated as well as ruptured. Rupture of the spleen is rare without other serious injuries. An enlarged spleen is far more liable to injury than a normal organ. The usual symptoms of abdominal injury are present. In addition there are pain over the spleen and heart, tenderness over the spleen, and great shortness of breath. Hemorrhage is generally profuse but slow. The splenic blood contains numerous leukocytes and clots rapidly, hence the bleeding is usually arrested for a time, and a patient does not often bleed to death rapidly (Ballance).

Ballance points out that dulness is found in the left loin, but, because of the clotting of the blood, the dulness does not shift, as it does in bleeding from other intraperitoneal structures, when the position of the patient is shifted.

Treatment.—Ballance tells us that after a splenic injury there is shock, but after a time there is a distinct reaction. Wait for the reaction, and when it occurs remove the spleen.

Rupture of the Kidney (page 950).

Rupture of the Ureter (page 952).

Wounds of the Abdominal Wall.—Non-penetrating wounds are to be treated on general principles. They are sutured with great care and are firmly supported externally. Ventral hernia may follow a large wound.

Penetrating Wounds.—The *symptoms* of penetrating wounds of the abdominal wall are usually those of shock and hemorrhage, and later of septic peritonitis. Emphysema is apt to occur and viscera may protrude, and often do in the case of a large incised or lacerated wound. Extravasation of contents of intra-abdominal viscera is very apt to occur, and is sure to occur if the viscus was distended when injured. Normal urine and normal bile may do little harm, but if either excretion is septic disastrous consequences are certain to ensue. If intestinal contents escape, septic peritonitis is certain to occur. Bleeding is usually profuse and prolonged, because spontaneous arrest of hemorrhage from any considerable vessel will rarely take place within the abdomen.

Treatment.—The surgeon endeavors to discover promptly if a wound of the abdominal wall is or is not penetrating in character. This fact may be proved by protrusion of viscera, by the appearance of stomach-contents in the wound, or by a flow of bile, urine, or feces from the wound. If none of the above indications exist, and if there are no signs of serious hemorrhage, the wound should be irrigated with hot salt solution, and should be dressed with gauze, and every effort should be made to bring about reaction.

When reaction is obtained the wound should be enlarged layer by layer until it becomes obvious whether the peritoneum is open or not. Madelung of Strassburg points out that incision layer by layer will be of no use in settling the question of penetration if the wound is in the chest, the buttock, the perineum, or the back of a fat individual.[1] If after incision layer by layer it becomes evident that penetration has not occurred, the wound should be closed and treated on general principles. If it becomes evident that it has occurred, the abdomen should be opened at the point of penetration, and a thorough exploration of intra-abdominal structures should be made in order to determine the injury and be able to treat it properly.

In a case still doubtful after incision layer by layer, do an exploratory laparotomy in the middle line.

In every case in which it is evident that penetration has occurred laparotomy is necessary in order to detect and correct intra-abdominal injury, and clean the peritoneum by flushing with hot salt solution. If viscera protrude, they must be washed off with hot salt solution and covered with hot sterile pads, and after the patient has reacted the wound should be enlarged, the contents of the abdomen investi-

[1] *Annals of Surgery*, September, 1897.

gated, hemorrhage arrested, wounds properly treated, and the viscera returned.

It is customary to flush the belly with hot salt solution, some of the fluid being allowed to remain. This proceeding mechanically cleanses the peritoneum, removes blood-clots, and strongly combats shock. It is not absolutely necessary to flush out the belly unless a considerable hemorrhage has occurred, or feces or stomach-contents have been extravasated. If extravasation of stomach-contents or feces has occurred, not only should flushing be practised, but evisceration should be carried out; the fouled intestine should be wiped off with gauze pads wet with hot salt solution, and be wrapped in hot moist towels; the peritoneal fossæ should be rubbed with gauze pads and the space between the liver and diaphragm should be carefully wiped.

A wound of the stomach may be sutured; a wound of the bowel may be sutured or resection and anastomosis or resection and end-to-end suturing may be required. Visceral injuries are treated by appropriate means. In a punctured wound or a gunshot-wound of the intestine, rectal insufflation of hydrogen gas may disclose the nature of the injury, but evisceration may be required.

After the completion of intra-abdominal manipulations the surgeon restores any protruding bowel.

Drainage is required when the contents of the stomach or the intestines have escaped, when hemorrhage is severe, or when the liver, pancreas, kidney, or spleen is found to be damaged. The peritoneum may be sutured with a continuous suture of catgut, and the muscles, fascia, and skin with interrupted sutures of silkworm-gut, or through-and-through sutures of silkworm-gut may be used. Active stimulation and artificial heat are needed immediately after the operation to combat shock. In many cases intravenous infusion of hot normal salt solution is of great value. It may be given both during and after operation. Enteroclysis, or high rectal injection of hot saline fluid, is useful. So is hypodermoclysis, or the subcutaneous injection of hot salt solution. The after-treatment consists of rest, avoidance of food by the stomach for forty-eight hours, and the administration of brandy and water from time to time. For two days the patient should be fed by the rectum. On the appearance of the first sign of peritonitis, forty-eight hours or more after the operation, give a saline cathartic. It is not wise to purge during the first forty-eight hours after the operation. When there is no sign of peritonitis, a purge should not be given

until the fourth day. After forty-eight hours liquid food can usually be given by the stomach. Solid food may be given after seven or eight days, but the patient must not leave his bed until the wound is firmly united, because of the danger of ventral hernia. A support should be worn for a long time.

Gunshot-wounds of the Abdomen.—If a bullet has penetrated, it may or it may not have produced visceral damage. A pistol-bullet or the bullet of a sporting-rifle usually does; a projectile of a modern military rifle may not or may produce wounds which can be recovered from without operation. If symptoms of hemorrhage exist, in either military or civil practice, the abdomen should be opened in the midline, the source of hemorrhage should be found and the bleeding should be arrested, and a search should be made for visceral injuries. The hydrogen gas test is of value in locating an intestinal perforation. If the ether-test of Sutton is used, the odor of the drug is detected as the vapor emerges from a perforation. No prolonged search for the bullet is permissible. In civil practice, laparotomy should be performed for a penetrating gunshot-wound of the abdomen. In military practice this rule cannot always be carried out. In fact, it has been proved that the modern small bullet may perforate the abdomen, and yet recovery may follow with a singular absence of serious symptoms.

Stomach and Intestines.

Foreign Bodies in the Alimentary Canal.—Foreign bodies of considerable size are rarely taken into the alimentary canal except by children, insane people, or drunkards. Most foreign bodies swallowed are passed with the feces, but some lodge. Any body which can pass the esophagus is not too large to pass through the intestines. A foreign body may lodge in the stomach. In some cases there are no symptoms. In other cases symptoms are violent. The severity of the symptoms depends upon the shape and character of the body.

In some cases it is possible to feel the body from without. A metal body in the stomach will deflect a magnetic needle held over the viscus (Polaillon). Many foreign bodies can be skiagraphed. It is not wise to attempt to recover the body by inducing vomiting. In some cases gastrotomy is necessary. When a foreign body has been swallowed the usual treatment is as follows: a purgative should *never* be given to expedite the passage of a foreign body, because

increased peristalsis means increased danger of impaction or of perforation. Endeavor to encrust the foreign body, and thus lessen the danger of perforation, by feeding with bread and milk only for several days, and at the end of this period give a mild laxative. An exclusive diet of mush or of mashed potatoes has been suggested. Pain is relieved by opium. A foreign body rarely lodges in the duodenum, but may lodge lower down, and may cause ulceration, perforation, abscess, or intestinal obstruction. Operation may be necessary in such cases.

Carcinoma of the Stomach.—Innocent tumors and sarcomata occasionally attack the stomach, but they are infinitely rare in comparison with primary cancer. This disease is unusual before the age of forty. It is more common in men than in women. In a very few instances cancer has been found to have arisen from an ulcer. The forms of cancer met with, set forth in their order of frequency, are, according to Osler, epithelioma, encephaloid, scirrhus, and colloid. Cancer may be limited to the body of the stomach (either curvature or either wall), the pyloric end, or the cardiac end; but it may involve two of these regions, or almost the entire stomach, or, being multiple, may be found in many parts. It is usually fatal in from four months to two years.

Symptoms.—The disease comes on gradually, usually with indigestion and physical weakness. The patient has persistent dragging pain, which is increased by eating and pressure, and attacks of vomiting are frequent. After a short time the patient becomes very weak and excessively anemic, and it is often possible to feel a tumor in the stomach. Blood examination shows diminution of red corpuscles and hemoglobin, and absence of any increase of leukocytes after a full meal. The vomiting of gastric cancer is at first only occasional, but as the case progresses it becomes more and more frequent. Vomiting soon after eating occurs when the cardiac region is involved; vomiting an hour or so after eating occurs when the pyloric end is involved. When the body of the organ is the seat of disease, vomiting may be absent. The vomited matter is often mixed with a small amount of altered blood (coffee-ground vomit). In most cases free hydrochloric acid is not found in the stomach, but lactic acid is found and Oppler's bacillus can often be detected. Examine with care a patient in whom cancer is suspected.

Distend the stomach with gas or fluid and map out its outlines. Feel for a tumor. A tumor can usually be felt if it involves the greater curvature, or anterior wall, and a large

tumor of the pylorus can be palpated, but in other regions the tumor can rarely be felt. Give a test-meal, siphon off the contents of the stomach, and examine for free hydrochloric acid, lactic acid, and Oppler's bacilli. Ewald's test-breakfast is usually employed. It consists of a dry roll and three-fourths of a pint of weak tea or warm water. It is given on an empty stomach. After an hour the stomach-tube is introduced. The fluid is removed by a pump or by abdominal compression.

Cancer of the cardiac end interferes with the entrance of food into the stomach, and in such a case the stomach is shrunken and the esophagus is dilated immediately above the growth. In cancer of the pylorus the food is partially or completely arrested as it passes to emerge from the stomach, and the stomach becomes much dilated. The vomited matter in a case of cancer rarely contains recognizable fragments of the growth, but fluid with which the stomach has been irrigated may contain pieces which can be identified as cancer (Rosenbach).

In cancer of the stomach the general course of the temperature is normal, but there are occasional deviations to below or above normal. In many cases the urine contains albumin, indican, acetone, and casts. Cancer of the stomach is apt to involve secondarily adjacent organs or structures, especially the liver. In many doubtful cases exploratory incision is justifiable.

Treatment.—The *medical* treatment consists in milk-diet, and the use of morphin and of lavage if the pylorus or body of the stomach is diseased. Perform lavage as follows: The tube for lavage should be long enough to extend about three feet out of the mouth when the other end is in the stomach, it should be flexible, should have an opening in the stomach-end and another opening on the side about one inch above the stomach-end. The tube should be greased with glycerin. The patient sits down, throws the head back, opens the mouth widely, and is directed to take deep breaths at regular intervals. The tube is carried into the pharynx, the patient is ordered to make efforts to swallow it, and the tube is thus taken into the stomach. About one quart of fluid is poured into the funnel-like end of the tube, and just before the tube empties itself of the last of the water the funnel is lowered and the fluid runs out. This proceeding is repeated till the fluid becomes clear. The best fluid to use is a solution of bicarbonate of sodium, a teaspoonful to a quart of warm water. Lavage should be

practised before breakfast, and sometimes also at bedtime.

Surgical treatment aims at the removal of the growth, or obviating the effect of obstruction at one of the orifices of the stomach.

In cancer of the body of the stomach, if the growth is not extensive, excision may be performed; if it is extensive, it is useless to attempt it unless the growth is absolutely nonadherent. Schlatter of Zurich, Brigham of San Francisco, Richardson of Boston, and Macdonald of San Francisco have successfully removed the entire stomach and attached the esophagus to the small intestine. In these cases digestion was satisfactorily performed after removal of the stomach. Very rarely will cases be found suitable for such a radical proceeding. The case suitable for this treatment is one in which the entire stomach is involved in the growth, in which there is no obvious glandular involvement, and in which the stomach is not adherent but is freely movable. In cancer of the cardiac orifice of the stomach the surgeon usually keeps the passage open as long as possible by the frequent passage of a tube, and through this tube introduces liquid food. Sometimes a small tube is introduced and permanently retained. When it becomes difficult to introduce a tube gastrostomy is performed. A better rule is to perform gastrostomy as soon as there is difficulty in swallowing liquids. In cancer of the pylorus limited in extent and without lymphatic involvement, pylorectomy may be performed; but in cancer which has widely infiltrated the coats of the stomach and has involved the lymphatic glands, gastro-enterostomy is performed as a palliative measure, the patient during the rest of his life subsisting upon liquid or semiliquid foods and submitting to frequent irrigation of the stomach to remove food-residue. In cases of irremovable cancer it is usually best to create the opium-habit.

Peptic Ulcer of the Stomach.—Ulcer of the stomach is a condition due to digestion of a portion of the stomach-wall by very acid gastric juice, the destroyed portion having been the seat of lowered vitality.

Ulcers are more common in females than in males, and are more frequent in young women than in those of middle or advanced age. Men about forty and women under forty are particularly liable. There is usually a single ulcer, but in some cases there are two or more. The ulcer may heal or may perforate. The most common seats of ulcer are the posterior wall and lesser curvature, especially in the pyloric

region. Only 2 per cent. of ulcers on the posterior wall perforate, as they tend to form adhesions to adjacent structures (Alderson). Ulcers on the anterior wall are unusual, do not tend to form adhesions, and are apt to perforate. Disorder of menstruation may develop ulcer, so may tight lacing, and habitually bending over, as in making shoes. Chlorosis is associated with ulcer in may cases. Traumatism and swallowing corrosive liquid may lead to ulceration. Alderson believes that alcoholism, syphilis, and mental anxiety may lead to the condition. Ulcers due to syphilis and tubercle are not, be it remembered, peptic ulcers.

Symptoms.—Acid dyspepsia exists, associated with much flatulence. In most cases, though not in all, food aggravates the condition. In many of these patients vomiting occurs about two hours after eating. The vomited matter contains much hydrochloric acid. Hemorrhage from the stomach tends to occur. The blood may be brought up with food, and is then black and clotted, or may be vomited clear and in large amount. In some cases blood from the stomach is passed by the bowels in part or wholly. Paroxysmal pain exists, which is usually, but not invariably, aggravated by taking food. The pain is very violent in the abdomen, and also passes to the back, being located between the eighth and ninth lumbar? vertebræ.

In gastric ulcer it is usual to find tenderness developed by abdominal pressure.

If the ulcer does not cicatrize, but progresses, causing pain and hemorrhage, the patient becomes thin, anemic, weak, and even exhausted.

It is highly probable that many cases of gastric ulcer are unrecognized; in fact, as Habershon says, diagnosis is rarely made unless hemorrhage exists, and in certain latent cases both vomiting and bleeding are absent.

A gastric ulcer may cicatrize and thus become cured; but the cure of the ulcer may prove the ruin of the stomach by producing stenosis of one of the stomach-orifices or hourglass contraction of the body of the stomach. An ulcer may perforate, causing sudden violent pain, greatly increased by swallowing fluids, acute abdominal tenderness, muscular rigidity, and rapidly increasing collapse. In some cases death quickly happens in collapse; in other cases there are temporary reaction and the onset of acute peritonitis. Vomiting is unusual after rupture. The area of liver-dulness is diminished or abolished. Perforation occurs after a meal or after drinking liquid, and is brought about by muscular

effort. Alderson calls attention to the fact that the sudden perforation of an ulcer may be mistaken for poisoning, and he cites the death of the Duchess of Orleans in 1670.[1]

Treatment.—*Medical.*—Rest in bed. Rectal feeding for a time, followed by the use of a bland diet. Lavage twice a day. To some cases Carlsbad salts are given (Ziemssen), to others silver nitrate, bismuth subnitrate, or oxalate of cerium. If pain is severe, opium is required.

Surgical.—If the patient grows worse in spite of medical treatment, if the hemorrhage has been profuse, if the pain is violent, or if tenderness is marked, open the abdomen and inspect the stomach. An ulcer may be removed by an elliptical incision in the long axis of the stomach, the coats being sutured by the usual method. If the patient is bleeding to death because of an ulcer, open the abdomen while an assistant is giving an intravenous injection of salt solution, open the stomach, turn out clot, find the source of bleeding, and excise the ulcer. In perforation bring about reaction from shock and open the abdomen. When the abdomen is opened there is an escape of odorless gas (Aufray), and food or fluid may be discovered in the peritoneal cavity. There may be adhesions. The perforation is found and excised, the stomach is washed out, the perforation is sutured, the abdominal cavity is cleansed, drainage is inserted, and the wound is sutured. Of late a number of cases have been successfully operated upon (see Barling, etc.).

Cicatricial stenosis of the orifices of the stomach results from the healing of an ulcer, the swallowing of a corrosive substance, or traumatism from a foreign body. Constriction of the *cardiac orifice* is indicated by gradually increasing difficulty in swallowing. After a time the esophagus above the stricture dilates or pouches; the fluid food passes into the stomach, but the solid food lodges in the esophageal pouch and is soon regurgitated. The site of the stricture is located by a bougie, and by having the patient swallow while auscultating over the esophagus and cardiac end of the stomach. If the constriction be malignant, the patient will be found to be beyond middle life, the vomit is occasionally bloody, emaciation is rapid and decided, and occasionally the supraclavicular glands are enlarged. A tumor of the cardiac end of the stomach can rarely be felt. If the constriction be cicatricial, the history will indicate the cause. Constriction of the *pyloric orifice* causes retention

[1] *Provincial Medical Journal*, Dec. 2, 1895.

of food and dilatation of the stomach. Dyspeptic symptoms will be found to have been long present. A tube passed into the stomach permits of the injection of fluid so as to fill the stomach. When the fluid runs out it contains portions of undigested food eaten days before, and measurement of the liquid shows that the capacity of the stomach is enormously increased. If hydrogen be forced through the tube, the outline of the distended stomach is at once made clear. The usual method of distending the stomach is by Seidlitz powder: two solutions are made; the bicarbonate solution is swallowed at once, and the tartaric solution is taken afterward in small amounts at a time. Percussion over the distended stomach indicates the size of the viscus.

In malignant disease of the pylorus a tumor may often be made out; there are tenderness and considerable persistent pain, great cachexia and emaciation, absence of free hydrochloric acid from the gastric juice, diminution of red corpuscles and hemoglobin, and no increase of white corpuscles after a full meal. There is sometimes enlargement of the supraclavicular glands. Vomiting of bloody fluid occurs in 40 per cent. of cases. Illumination of the stomach by the gastrodiaphanoscope may aid the diagnosis, the area of malignant growth interfering with the transmission of light. In cicatricial stenosis of the pylorus there may be paroxysms of pain, there is no tenderness, emaciation is not so rapid in onset, and the supraclavicular glands are never enlarged. Vomiting occurs, but the ejected matter is not bloody.

Treatment.—Cicatricial cardiac stenosis requires dilatation with bougies and the maintenance of the restored caliber. If dilatation from above is unsatisfactory, perform a gastrotomy, push a small bougie from the mouth into the stomach, tie a string to the bougie, draw the string through the stricture, use the string as a saw to cut the fibrous bands, pass a full-sized bougie, close the wound in the stomach, and maintain the caliber of the cardiac orifice by the repeated passage of dilating instruments. If no instrument can be passed through the stricture from above, perform a gastrotomy, introduce an instrument from below and pass it into the mouth, tie a string to it, draw the string into the stomach, and use Abbe's string-saw. If no instrument can be passed from below, convert the gastrotomy into a gastrostomy. In malignant stenosis of the cardia gastrostomy should be performed early. Cicatricial pyloric stenosis is treated by a

gastrotomy and digital divulsion of the stricture (Loreta's operation), by pyloroplasty (Heineke-Mikulicz operation), or by gastro-enterostomy. Malignant stenosis is treated by pylorectomy or gastro-enterostomy. (See under these heads respectively).

Intestinal Obstruction (Ileus or Enterostenosis).—Intestinal obstruction is a condition in which fecal movement is mechanically impeded or prevented. It may be either *partial* or *complete*. *Acute obstruction* is due to a sudden narrowing or occlusion of the lumen of a portion of the intestine. *Chronic obstruction* is due to a gradual narrowing of the lumen of a portion of the intestine, and it may at any time become acute. If obstruction to circulation in the wall of the bowel occurs, the condition becomes one of strangulation. Intestinal obstructions are classified[1] as follows:

1. *Strangulation by bands or in apertures*, the commonest form, is due to peritoneal adhesions, but the band may come from the omentum. Strangulation may take place by Meckel's diverticulum, a structure due to persistence of the vitelline duct, and coming off from the ileum from twelve to thirty-six inches above the ileocecal valve. Strangulation may take place beneath an adherent appendix, a Fallopian tube, a portion of mesentery, or the pedicle of an ovarian tumor, or it may take place in an omental or a mesenteric aperture. Strangulation by bands or in apertures usually involves the ileum, and sometimes the colon. This form of obstruction is identical with hernia, excepting in the absence of an external protrusion.

2. *Volvulus*, or twisting of the bowel. The twist may be about the mesenteric axis or on the axis of the bowel itself, or two intestinal coils may be twisted together. Volvulus is commonest in the sigmoid flexure. It may occur in a hernial sac.

3. *Intussusception* is the invagination of a portion of bowel-wall into the lumen of an adjacent part. One-third of all cases of obstruction are due to this cause (Treves). Most cases of obstruction in children are due to intussusception. There are four varieties: the *ileocecal*, in which the ileum and the ileocecal valve pass into the cecum and colon; the *colic*, in which the large intestine is prolapsed into itself; the *ileal*, in which the small intestine alone is involved; and the *ileocolic*, in which the ileum prolapses through the ileocecal valve. The first variety is the commonest. Intussusception is due to active peristalsis.

[1] After Treves, in *Heath's Dictionary*.

4. *Stricture of the intestine*, which may be either cicatricial or cancerous.

5. *Obstruction by Tumors of the Bowel and by Foreign Bodies.*—Tumors may be innocent or malignant. Foreign bodies include, besides certain substances that have been swallowed, gall-stones, and enteroliths or intestinal calculi. Foreign bodies are apt to lodge in the lower portion of the ileum or in the cecum, and they may cause ulceration at the seat of lodgement. If a gall-stone is sufficiently large to cause obstruction, it cannot have passed the duct, but must have ulcerated into the bowel from the gall-bladder (Treves).

6. *Obstruction by tumors, etc., outside the bowel*, among the causes of which are retroflexion or retroversion of the womb, especially in pregnancy, cysts or tumors of the kidneys, ovaries, uterus, etc., floating kidney, and enlarged spleen. Obstruction from any of the above causes takes place in the rectum or the sigmoid flexure.

7. *Obstruction from fecal accumulation* is due to paresis or paralysis of the bowel and the diminution or abolition of peristalsis. Obstruction may follow an abdominal operation. Paresis or paralysis arises in the colon. Treves mentions among the rare forms of obstruction kinking of the bowel, adhesions matting the bowels together or compressing the gut, and shrinking of the mesentery.

Symptoms of Acute Obstruction.—Severe colic comes on suddenly, the pain varying in intensity, but at no time entirely ceasing. In a suddenly arising intraperitoneal accident, whether it be perforation, acute obstruction, or acute strangulation, there is at first shock, from which the patient usually reacts for a time. There is constipation, which soon becomes absolute, not even wind being passed; vomiting is early—first of the contents of the stomach, next of bilious matter, and finally of feces (stercoraceous); the abdomen becomes distended and tender. After reaction from shock some fever may be noted, but in any unrelieved case collapse soon arises; the temperature becomes subnormal; the face Hippocratic; the pulse rapid and feeble. The amount of urine passed is very small. In obstruction of the upper third of the ileum true fecal vomiting cannot occur. The tongue is dry, the mind is clear, and muscular cramp may occur. Intestinal peristalsis above the obstruction may be detected through the abdominal wall. If obstruction is high up in the small intestine, tympanites does not occur.

Symptoms of Chronic Obstruction.—At intervals there

arise attacks of pain which become gradually more frequent and severe, and are linked with vomiting and constipation. the vomiting not being stercoraceous and the constipation not being absolute. Between the painful seizures the patient complains of constipation alternating with fluid diarrhea, distention of the belly, some abdominal uneasiness, anorexia, and dyspepsia. The attacks recur with increasing frequency and severity, and acute obstruction may arise or the patient may be worn out by pain, vomiting, and want of food.

Diagnosis.—*The determination of the seat of lesion* requires abdominal and rectal examination. An intussusception may sometimes be felt. Vaginal examination may be demanded. Pain is apt to arise at the seat of obstruction or to radiate from there. Palpation may detect a tumor. Rectal insufflation of hydrogen may locate the obstruction by causing great distention below it. Entire suppression of urine, early vomiting which is not truly stercoraceous, absence of abdominal distention, and rapid collapse mean obstruction in the duodenum or in the jejunum. Early vomiting, which is often stercoraceous in a rapidly progressive case with great distention of the umbilical region, means obstruction of the ileum or the cecum. Distention of the entire abdomen and of the flanks, linked with tenesmus, with less intensity of symptoms, less rapidity of progress, and less diminution of urine than in the above-cited forms, means obstruction low down in the colon or in the rectum. A test for obstruction in the adult large intestine is an injection by a fountain-syringe; if six quarts can be introduced, there is no obstruction in the large intestine; if less than four quarts can be introduced, there is probably obstruction in the large intestine. The passage of a sound in the rectum is generally useless and is often unsafe.

The determination of the causative condition is always difficult and is often impossible. Intussusception is the common cause in children. A sausage-shaped tumor can usually be felt in the right iliac fossa, tenesmus exists, and bloody mucus is passed. The abdomen is rarely distended or tender. Vomiting occurs, but it is seldom stercoraceous. The prolapse may sometimes be detected by digital exploration of the rectum. In obstruction from bands, internal hernia, etc., there is a record of antecedent peritonitis, of a traumatism, of a violent effort, or of pelvic pain. The attack is sudden in onset, is fierce in character, and is usually excited by violent exercise or the taking of food. Vomiting is early and intractable, and it soon becomes stercoraceous; pain is vio-

lent; peristalsis above the obstruction is forcible; tympanites and abdominal tenderness appear after the attack has lasted for some little time; obstruction is complete, no wind even being passed; collapse soon arises; no tumor can be detected, and rectal examination is negative. Volvulus, which is usually located in the sigmoid flexure, is preceded by constipation. The symptoms come on with explosive suddenness, and rapidly attain great severity. Constipation is absolute; vomiting is late and is rarely stercoraceous; no tumor can be detected; rectal examination is negative; abdominal distention and tenderness are early and pronounced; peristalsis above the volvulus is vigorous; collapse is not so rapid nor so grave as in the previously-considered forms. Obstruction by a foreign body may sometimes be inferred from the history of some such body having been swallowed. The obstructing body may occasionally be felt during palpation, or may be discovered with the *x*-rays. Abdominal distress may exist for days or weeks before obstruction occurs. Vomiting is late and is rarely severe, but pain, tenderness, and distention are marked. In obstruction from gall-stones there will be a record of one or more attacks of hepatic colic. Pain is early and acute, and vomiting is invariable and usually becomes stercoraceous. In obstruction from fecal accumulation chronic obstruction evolves into acute obstruction, pain and vomiting are late or even absent, and the dough-like mass of feces may often be felt by rectal examination or by abdominal palpation. In some cases the fluid elements of the feces pass, but the solid elements agglutinate to the walls of the bowel (the diarrhea of constipation). Obstruction from stricture or from pressure comes on acutely after a prolonged period of disturbance, during which period attack after attack of temporary obstruction, complete or partial, takes place. A history of blood or pus in the stools would indicate tumor of the bowel; a history of blood or pus having been absent would indicate pressure from without (Pepper). In functional obstruction there is no local pain, no tenderness, no tumor, no tendency to collapse, but simply distention and absolute constipation, and possibly non-fecal vomiting occurring in a neurotic or hysterical subject. A phantom tumor due to a local distention of the intestine from limited muscular spasm disappears under ether. Obstruction may follow an abdominal operation (postoperative obstruction); it may arise a day or so after operation; it may arise in ten or twelve days after operation; it may not arise for weeks or months (Legeve). It may be due

to some cause at the seat of operation (adhesion of the bowel to a raw surface, volvulus, catching of the intestine under adhesions, etc.). It may be due to some cause distant from the seat of operation (displacement of intestine, bands, etc.). It may arise from paralysis of a portion of the bowel, which may or may not be due to sepsis.[1]

Recognition of Intestinal Obstruction from Other Diseases.—Always examine for a strangulated hernia at every hernial outlet. If obstruction is complicated with an irreducible hernia above the seat of lesion, the hernia will always enlarge and become tender because of accumulation of feces. Functional obstruction may attend peritonitis or may follow the reduction of a hernia. Appendicitis with peritonitis may cause symptoms similar to those of obstruction; but there are fever, a history of pain in the right iliac fossa, and the vomiting is not stercoraceous. Acute hemorrhagic pancreatitis produces symptoms so nearly identical with those of intestinal obstruction that a diagnosis cannot always be made. Poisoning by arsenic or by corrosive sublimate should not be confounded with intestinal obstruction.

Prognosis.—Without surgical interference most cases of acute intestinal obstruction die within ten days, usually within seven days. Death may be due to shock, to exhaustion, to perforation, to peritonitis, or to obstruction of respiration and circulation by tympanites. Recovery occasionally happens by the formation of a fistula externally or into another portion of the bowel. In acute obstruction from foreign bodies the obstructing body occasionally passes. Volvulus and strangulation by bands are almost invariably fatal unless an operation is performed. In intussusception recovery occasionally follows the sloughing away of the prolapsed gut, but stricture almost inevitably results from this rare event. Functional obstruction gives a good prognosis. The prognosis of chronic obstruction depends upon the causative lesion, and is not nearly so grave as is that of acute obstruction.

Treatment.—In any abdominal case, where the diagnosis is uncertain and the patient is shocked, give an enema of brandy and hot water, wrap the patient in blankets, surround him with hot-water bottles, and study the development of symptoms and signs. In half an hour, as a rule, reaction will be brought about, and a probable diagnosis may be made (Greig Smith). In acute obstruction it is usually customary to empty the stomach by lavage and to evacuate the rectum by means of copious injections given while the patient is in

[1] Legeve, *Gaz. des Hôp.*, November 23, 1895.

the knee-chest position. Hutchinson's method of taxis and massage is uncertain, and is as liable to inflict harm as to confer benefit. Some surgeons apply constant compression to the abdomen by means of straps of adhesive plaster. Puncture of the intestine with an aseptic hypodermatic needle introduced obliquely to relieve gaseous distention is a decidedly dangerous proceeding. The passage of a small tube from the anus to the sigmoid flexure will empty the colon of gas if no obstruction intervenes. In intussusception give no food by the stomach; give opium and belladonna to stop peristalsis, wash out the rectum with copious injections, give an anesthetic, and insufflate hydrogen gas or carbonic acid gas in order to distend the bowel. Some surgeons treat intussusception by forcing air into the rectum by means of an ordinary bellows, and others inject water by a fountain-syringe, the reservoir standing at a height of three feet. D'Arcy Power believes in the value of hydrostatic pressure in intussusception in children. He states that the child should be anesthetized and the large intestine filled *gradually* with hot saline fluid, the reservoir not being raised more than three feet above the patient. The fluid should be retained for ten minutes. The author is of the opinion that injections of gas or liquid should be tried during the first twenty-four hours of the attack, but not later, because later ulcer or gangrene may exist. Pressure cannot be accurately regulated, and if the bowel is much damaged may lead to rupture. If the case is not seen until after the first day, or if injections have been used and have failed, laparotomy should be performed.

Frederick Holme Wiggin has made a study of the reported cases of laparotomy for infantile intussusception, and considers that operation done within the first forty-eight hours will give a mortality of 22.2 per cent.[1] (see Operation for Intussusception).

In obstruction from fecal impaction use large rectal injections and give small repeated doses of salines or of a mixture of castor oil and oil of turpentine. If there are signs of inflammation, do not give cathartics, even in small doses, but give opium and belladonna to arrest vomiting and to relax spasm. Impactions in the rectum can be removed by the use of a spoon. In acute intestinal obstruction, if the symptoms grow worse, do not wait, but open the abdomen before collapse comes on and find the cause of the obstruction. If it is a gall-stone or enterolith, try to crush it without opening the intestine; if this fails, push

[1] *Medical Record*, January 18, 1896.

it up a little distance, incise the bowel, remove the stone, and close the incision with Halsted sutures. If there is fecal obstruction, break up the masses by pressure and push the fecal plug down without opening the bowel. If there is intussusception, reduce the prolapse and shorten the mesentery; but if reduction is impossible, perform an anastomosis or a resection and enterorrhaphy, or make an artificial anus. In volvulus untwist and shorten the mesentery; but if this is impossible, treat as an irreducible invagination. In obstruction from adhesions try to separate them and straighten out the bowel, stitching healthy peritoneum over each raw spot to prevent recurrence. Anastomosis may be necessary. In flexion separate the intestines, remove the flexion by a V-shaped incision, and suture the wound in the bowel (Senn). In chronic obstruction it is often advisable to perform an exploratory laparotomy, discover the condition, and determine what is to be done to correct it. Some tumors external to the bowel may be removed. Growths in the bowel-wall may be removed by resection of the involved portion of intestine, or an anastomosis may be performed, or it may be necessary to make an artificial anus. Post-operative obstruction coming on soon after a surgical operation is often not recognized for a time, and the surgeon will be in doubt as to whether he is dealing with peritonitis or intestinal paresis. When in doubt wash out the stomach with warm salt solution, administer salines in small doses frequently repeated, and employ enemata. If these measures are not soon successful, open the abdomen; never wait for the advent of stercoraceous vomiting (see Legeve).

Fecal Fistula.—A fistula is an abnormal opening in the intestine through which gas or a portion of the feces escapes (Fig. 268). If all the intestinal contents escape through the

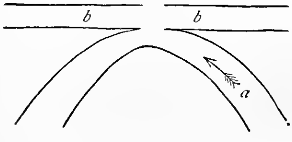


FIG. 268.—Fecal fistula: *a*, direction of fecal flow; *b*, *b*, belly-wall.

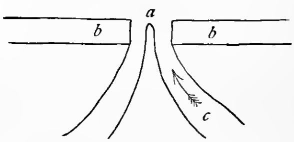


FIG. 269.—Artificial anus, showing spur: *a*, spur; *b*, *b*, belly-wall; *c*, direction of fecal flow.

opening, it is called an artificial anus (Fig. 269, Senn). A surgeon may make a fistula deliberately (intentional fistula). A fistula may be the product of disease or injury (accidental fistula). Senn enumerates the following causes of accidental

fistula: wounds, injury of the intestine, intestinal ulceration, intestinal strangulation, foreign bodies in the intestinal canal, malignant tumors, actinomycosis, pelvic and abdominal abscess, appendicitis, injury of the bowel during an abdominal operation, the application of ligatures, catching by sutures, and the employment of drainage-tubes.

Treatment.—Many fistulæ close spontaneously. This can only be hoped for if the opening is quite small, if the general health of the patient is good, if the cause has passed away, if the fistula is not lined with mucous membrane, and if there is no spur (spur is shown at *a*, Fig. 269). In most cases of fistula not high up it is well to give Nature a chance to effect a cure, and not to be in a hurry to operate. The part is cleansed frequently with peroxid of hydrogen, the patient is kept recumbent, food is given which does not leave much residue, pads of gauze with pressure are applied, and the bowels are kept regular.

If the track is lined with granulations, it may be touched with lunar caustic; if it is lined with mucous membrane, the actual cautery should be applied; any collection of pus which exists should be drained. If these methods fail, an operation must be performed. The fistula may be sutured by extraperitoneal manipulation (Greig Smith); it may be covered with skin (Dieffenbach); the spur may be removed by means of a clamp; or resection may be performed. In most cases it is best to incise a button of skin around the opening, temporarily suture the fistula, open the peritoneal cavity, deliver the bowel, and suture carefully (Senn's method). In some cases exclusion of the fistulous part is necessary, the bowel being divided above the fistula, the end near the fistula sutured, and the other end anastomosed to the bowel below the fistula.

Ulcer of the Bowel.—In typhoid fever and in dysentery ulceration occurs. An ulcer may be due to tuberculosis or cancer. Ulcer in the duodenum sometimes follows a severe burn of the cutaneous surface of the body (Curling's ulcer). An ulcer may heal, and by causing thickening and constriction produce intestinal obstruction. It may perforate, causing collapse and subsequent peritonitis. In perforation the liver-dulness is greatly diminished or disappears because of free gas in the peritoneal cavity. Perforation of a typhoid ulcer is preceded and accompanied by marked leukocytosis; there is great shock, which is usually followed by a temporary reaction, severe pain, as a rule, tenderness, costal respiration, abdominal distention, vomiting

which may become eventually stercoraceous, constipation, percussion-dulness in the flanks, and Hippocratic face.

Treatment.—The intestinal obstruction due to the healing of an ulcer is treated by intestinal anastomosis or resection. If an ulcer perforates, the surgeon aims to bring about reaction. If this attempt succeeds, the abdomen is opened and is flushed with hot saline fluid, special care being taken to cleanse the pelvis, the peritoneal fossæ, and the space between the liver and diaphragm. In perforation Finney always eviscerates, closes the perforation, wipes out the peritoneal cavity with gauze pads, and returns the bowels slowly into the abdomen, wiping them carefully. The perforation is to be sought for, and when found is to be sutured. It is not necessary to excise it. A suprapubic incision, in addition to the first incision, affords better drainage, and in some cases posterior drainage is obtained by an incision through the right kidney pouch. A drainage-tube is placed in each incision, and a tube is inserted in the suprapubic incision and is carried into Douglas's pouch, and the upper incision is left open, strands of iodoform gauze being placed over the area of rupture and in several places among the intestines.

Malignant Tumor of the Intestine.—Sarcoma is very rare, but does sometimes arise, particularly in young persons, and it enlarges very rapidly. Cancer is not uncommon, attacking especially the middle aged. It is most common in the neighborhood of the ileocecal valve and in the sigmoid flexure. It produces pain at the seat of growth, and after a time intestinal obstruction. It is usually possible to feel the tumor, which is hard and immovable. The patient wastes rapidly and is apt to occasionally pass blood at stool. The growth is not very rapid and glands are not involved early. In some cases the supraclavicular glands enlarge.

Treatment.—Early in the case exploratory laparotomy should be performed, followed if possible by excision with end-to-end approximation. If excision is impossible, the growth should be sidetracked by performing lateral anastomosis. In advanced cancer of the large bowel, if resection is impossible, make an artificial anus above the tumor.

Appendicitis.—Appendicitis, which is an inflammation of the vermiform appendix of the cecum, is almost invariably the primary lesion of all of those various conditions known as typhlitis, perityphlitis, paratyphlitis, etc.—terms which no longer imply pathological entities, and are in most instances well relegated to obscurity. It was recognized by some ob-

servers many years ago that such a disease existed, but the majority of the profession did not grasp the fact. In 1750 Mestevier of France reported a case of perforative appendicitis. In 1827 Mellier described appendicitis, and named among its symptoms fixed pain in the right iliac fossa and colic. He said: "If it were possible to establish with certainty the diagnosis of this affection, we could see the possibility of curing the patient by operation. We shall perhaps some day arrive at this result."[1] The appendix is a diverticulum (musculomembranous in structure) which comes from the posterior and internal part of the head of the colon, and which has no physiological function (in herbivora and rodents it is a functionally active organ). The structure of the appendix is similar to the structure of the colon, except that the muscular structure is ill developed and trivial in amount. Lockwood points out that there is an extensive lymph system in the appendix, and that the submucous and subperitoneal tissues communicate by numerous gaps in the muscles.[2] The appendix averages about four and a half inches in length, and its diameter is, as a rule, about equal to that of a No. 9 English bougie; its canal is narrow and is partly closed by the valve of Gerlach (Talamon). The appendix enters the cecum at its posterior internal part, which is usually the seat of the most intense pain in inflammation, and corresponds to a point on the surface two inches from the spine of the ilium, on a line drawn from the umbilicus to the anterior superior iliac spine, which is known as "McBurney's point." The free part of the appendix in one-third of all persons is in relation with the posterior surface of the cecum; in almost one-third of all persons it is fixed in the iliac fossa, so that if perforation occurs the contents will be voided in the retroperitoneal tissue (iliac abscess). In some cases it is external to the cecum; in some it passes downward, and in some inward. It is important to remember that the appendix may be met with in the most unexpected situations. When the ascending colon is displaced the diverticulum may be upon the left side. It is not unusual to find its tip in the middle line, up toward or adherent to the gall-bladder, or in the pelvis. In about two-thirds of all cases the appendix is completely covered with peritoneum; in one-third of all cases it is in contact, in some part of its length, with cellular tissue (Talamon). Robinson has called attention to the fact that

[1] See R. J. Lee Morrill's article in the *American Medico-Surgical Bulletin*, Dec. 19, 1896.

[2] *British Medical Journal*, Jan. 27, 1900.

the appendix is frequently in contact with the psoas muscle in men.

Etiology and Pathology.—Appendicitis is very rare in infants, but is common at any period beyond childhood, being more frequent in young and middle-aged people than in the aged. Appendicitis is a bacterial disease. It is produced occasionally by pus cocci, but most commonly by the action of the bacterium coli commune of Escherich. These microbes, which normally inhabit the appendix, are harmless when the appendix is healthy, but become active for harm when the diverticulum is bruised, obstructed, irritated by the presence of uric acid, or congested because of chilling of the cutaneous surface of the body. When non-traumatic inflammation occurs swelling of the mucous membrane occludes the opening into the colon, and the lumen of the appendix dilates and fills up with a thick mucopurulent fluid. Ulcers sometimes form, which may only involve the mucous membrane, may pass deeply into the coats, or may even perforate. Dieulafoy[1] maintains forcefully that appendicitis is due *always* to the conversion of the appendix into a *closed* cavity, but cases are met with which disprove this assertion. Various conditions may bring about this transformation. Partial obstruction may be caused by calculi, which are composed of stercoral material and hordes of bacteria mixed with salts of lime and magnesia. These calculi are not formed in the colon, but are formed in the appendix. Dieulafoy speaks of the condition as appendicular lithiasis, and says the condition has a tendency to run in family lines, and has a kinship with gout and rheumatism. Obstruction may be caused by local infection of a catarrhal area, by the formation of a fibrous stricture, or by several causes acting in unison. The theory that concretions form in the colon, and are forced into the appendix by peristalsis, has been very largely abandoned. The presence of a concretion is always dangerous. It is frequently associated with ulceration, either as cause or effect. It is a mass of virulent bacteria. It may lead to perforation or gangrene. Talamon taught that the appendix resents the presence of the concretion, reflex contraction of the muscular coat taking place, which is accompanied by violent pain (appendicular colic). The muscular structure is so rudimentary that it does not seem probable that attempts at contraction, even should they arise, would produce violent pain and distant symptoms. Pozzi believes that appendicular colic may be caused by torsion or bending of the appendix, or

[1] *Progrès médicale*, No. 11, 1896.

malposition of the diverticulum, and holds that pain may arise when there is no lesion in the appendix and no inflammation of the peritoneum or pericecal structures.[1] The term appendicular colic has led to much injudicious conservatism, and, as Lockwood shows, if an appendix is removed from an individual who suffers from attacks of appendicular colic, it will usually be found that the diverticulum is inflamed or the lumen contains a concretion. Foreign bodies, such as pins, fish-bones, nails, buttons, date-stones, cherry-stones, and grape-seeds, may enter the appendix, but they do so far less often than is generally supposed, most alleged grape-seeds from the appendix being fecal concretions. Fitz found concretions in 15 cases out of 300. Ranvier collected the records of 459 postmortems, and found reported 179 fecal concretions and 16 foreign bodies. Appendicitis due to a foreign body, such as a grape-seed or a pin, is known as *traumatic;* appendicitis in which a concretion is the assumed cause is known as *stercoral.* A foreign body may produce instant perforation. If impaction of a foreign body or concretion occurs, the orifice of the appendix is closed, the circulation is soon cut off, the secretions are retained, the coats become congested, the diverticulum enlarges enormously, microbes multiply with great rapidity, and the wall of the congested appendix inflames and may become gangrenous or ulcerated, and is finally perforated. Interference with the blood-supply of the appendix will predispose to appendicitis. This may be brought about by twists, bruises, adhesions, concretions, pressure, or bands; and the psoas muscle may play a part in the production of these conditions. In women appendicitis is occasionally secondary to tubo-ovarian disease. Appendicitis is rarer in women than in men, probably because the appendix of a woman has a better blood-supply, the additional supply coming through the folds of the appendiculo-ovarian ligament. Catarrhal conditions of the intestine, habitual constipation, and indigestion with flatulence predispose to appendicitis. It seems probable that catarrhal appendicitis may result from extension of a catarrh of the colon, and may also arise from external traumatism. If before perforation the appendix adheres to the cellular tissue behind the cecum, cellulitis or abscess without peritonitis may result. When appendicitis goes on to perforation there is always some peritonitis; but if the steps to perforation are gradual, and if the causative organism is the colon bacillus, the peritonitis may be local, and will sometimes by formation

[1] *Progrès médicale*, No. 19, 1896.

of adhesions make a barrier between the appendix and the peritoneal cavity before perforation occurs. When perforation takes place suddenly diffused septic peritonitis is inevitable. When the causative organism is the streptococcus general peritonitis is very apt to arise. Peritonitis may arise without perforation by contiguity of structure or by migration of bacteria through the congested walls of an obstructed appendix. In some cases perforation takes place into the peritoneal cavity, but pus is circumscribed by matting together of the intestines with plastic exudate. The appendix may become gangrenous very rapidly or after some time. A case of appendicitis in which gangrene and perforation come on very quickly is spoken of as fulminating appendicitis. In some cases, if the perforation is very small and the appendix is swathed in lymph, or if perforation does not occur, the inflammation may subside. Perforation rarely occurs from liquid pressure or from the pressure of a concretion; it is generally due to ulceration produced by the action of micro-organisms. Appendicitis which subsides may at any time recur, and the life of the patient is under constant menace. An enormous number of people have had appendicitis. Toft recorded 500 autopsies, and in 36 per cent. of them there were positive signs of past attacks. The disease is occasionally unsuspected during life. These facts prove that the disease may subside without the aid of surgery.

Forms of Appendicitis.—In what is known as *appendicular colic* the appendix is temporarily obstructed because of swelling of the mucous membrane of the outlet, and the stercoral contents are retained in the diverticulum. This condition is called by Fergusson "constipation of the appendix." If not relieved, it will rapidly eventuate in appendicitis. It is an unfortunate term, sometimes used as an excuse for avoiding operation. In such cases a concretion is frequently or usually present.

Simple parietal or *catarrhal appendicitis* is not limited to the mucous membrane; hence the term *catarrhal* is not strictly correct. The vessels of the appendix are distended with blood, the lumen at the intestinal end becomes partially or completely obstructed, the epithelium desquamates from numerous glands, the mucosa ulcerates, and the lumen of the appendix becomes filled with a mixture of mucus, bacteria, and portions of organic matter. Bacteria enter the lymph-spaces of the wall of the appendix, and pass rapidly from the submucous to the subperitoneal tissues. Forty-eight hours after the mucous coat begins to inflame the peri-

toneal coat will probably be involved. This inflammation may undergo resolution and the patient get well or events may result disastrously. Suppuration or gangrene may occur, perforation may take place, or pyemia, with abscess of the liver, may arise. The acute condition may pass into chronic appendicitis, or ulcerations of the mucosa may remain; the mucous crypts may be filled with bacteria; a concretion may exist; cicatricial contractions may occur: in any one of these conditions the patient is in danger of a fresh attack at any time. In a catarrhal inflammation secondary to catarrh of the colon the case may be chronic from the beginning. If the lumen of the appendix is gradually and completely obliterated, the condition is denominated *obliterative appendicitis* (Senn). This progressive obliteration may result from repeated attacks of inflammation or may be simply a degenerative change. Recurrent appendicitis, it is said, may be due to inordinate size of the mouth of the appendix, making of this diverticulum a drag-net for foreign bodies; but it is more probable that it is due to smallness of the opening, so that it quickly closes and converts the appendix into a closed vase filled with septic material. *Suppurative appendicitis* is due to purulent infiltration of the walls. Pus in the lumen is not purulent appendicitis. *Gangrenous appendicitis* is a moist or septic gangrene, due to interference with the circulation and to tissue-destruction by the action of micro-organisms. Perforations occur, and they are often multiple. The entire appendix may slough off. Interference with circulation may be caused by an obstruction, by a bend, or twist, or bruise of the appendix, or by the action of virulent organisms on an appendix whose tissue-resistance is lowered by injury or disease. In gangrenous cases the vessels of the meso-appendix are usually obstructed by thrombi or the changes of arteritis (Van Cott).

Fowler suggests the following classification of cases of appendicitis: (1) endo-appendicitis; (2) parietal appendicitis; (3) peri-appendicitis; (4) para-appendicitis.

As a matter of fact, appendicitis is always one disease, which varies in intensity, and it is useless to divide it into a great number of symptomatic groups. In rare instances appendicitis is due to tubercular ulceration, in other cases to typhoid ulceration, and genuine appendicitis may arise during typhoid fever.

Symptoms.—In what is known as appendicular colic the patient suffers from disorder of digestion and occasionally has a brief attack of abdominal pain associated with trivial

and temporary tenderness in the right iliac fossa. The colicky pain is about the umbilicus and right iliac fossa; there is often nausea and usually constipation. This condition, if not soon relieved, is followed by the evidences of inflammation. The symptoms of genuine appendicitis are as follows: in some cases the patient feels out of sorts for a day or two; in others the trouble seems to begin suddenly. Constipation is very generally present, but in rare cases there is diarrhea. The sufferer complains of anorexia, dyspepsia, flatulence, colicky pain about the umbilicus, and later a feeling of weight, soreness, or pain in the right iliac fossa. Nausea is often present, and vomiting may occur. The tongue is coated. Examination discovers tenderness, rigidity, fulness, and pain in the right iliac fossa. The tenderness is most marked about McBurney's point. There is usually moderate fever, and the pulse as a rule is about 100, but may be less or more than this. The patient may get well, the symptoms gradually passing off. He may get rapidly or gradually worse. If he becomes worse, the tenderness increases; the pain becomes agonizing and radiates toward the umbilicus, and the patient draws up the right leg to relieve it. Pressure upon the left side often causes pain in the right iliac region. The pulse increases in frequency, the fever usually rises, the abdominal distention and rigidity become more marked, vomiting begins and becomes worse, and the respiration becomes shallow and thoracic. There are great thirst, anorexia, constipation, and mental anxiety. Absolute intestinal obstruction sometimes takes place. The urine is scanty and highly colored. Hiccoughs develop. If the inflammation continues for one or two days, swelling is often observed in the right iliac fossa, or is detected by a vaginal or rectal examination, or by bimanual palpation, or by examination under ether. It is not wise to forcibly palpate in acute appendicitis, as it may cause rupture. If the appendix is enlarged, and the individual has a thin abdomen which is not rigid, it is often possible to palpate the appendix. Sometimes it may be felt when the patient is anesthetized, though it could not be detected before.

A case of appendicitis may come on suddenly with pain, premonitory symptoms having never occurred. There are nausea and bilious vomiting, constipation, and distention of the abdomen. Such attacks are not to be considered as colic from the presence of a calculus. They are inflammatory, and are associated with fever and the other symptoms previously set forth. Examination detects tenderness in the right iliac

fossa. The point of greatest tenderness is known as "McBurney's point." This is apt to be about two inches from the anterior superior spine of the ilium, on a line drawn from the spine to the umbilicus. Pain at McBurney's point is linked with local muscular rigidity and hyperesthesia of skin. Such a case, like the former cases described, may get well or may get worse. In some cases all the symptoms are violent from the beginning, the attack tends to linger, and is followed by persistent soreness of the appendix and harassing digestive disturbances. Any case of appendicitis may become suddenly desperately grave because of perforation or gangrene. The temperature falls, hiccough begins, abdominal distention, pain, and tenderness become marked and general, and the pulse becomes very rapid. In some cases these grave symptoms are present almost from the start (fulminating cases). A sudden perforation produces collapse, and, if reaction takes place, general peritonitis arises. Peritonitis, be it remembered, may arise without either perforation or gangrene. If pus forms, it may be unlimited by adhesion. In such cases there is the rapid onset of fatal peritonitis and septicemia. Pus may be limited by adhesions and be practically extraperitoneal. In such a case a lump is felt in the right iliac region; and dusky discoloration and edema of skin sometimes exist. In an abscess case there are usually irregular fever and sweating. A limited collection of pus may be liberated into the peritoneal cavity by rupture of the abscess-wall. Such a rupture may be caused by pressure or muscular effort; rupture is followed at once by shock and later by diffused peritonitis. An abscess may rupture externally, or into the vagina, intestinal tract, or bladder. It is desirable, if possible, to locate the situation of the appendix, and this is usually determined by locating the seat of swelling and of greatest tenderness. The surgeon should not lose sight of the fact that the appendix may be found in the most unexpected situations. In every case a rectal or vaginal examination should be made, in order to detect swelling and tenderness, and thus determine if the inflammation took origin in or has come to involve the pelvic region. Pain at the end of micturition points to involvement of the vesical peritoneum.[1] In cases where there is not *localized* swelling and tenderness, as in gangrenous or perforative appendicitis with general peritonitis, "diagnostic localization" is impossible (Van Hook).

Terminations.—Appendicitis may terminate in complete recovery, in death, or in a condition of lowered vitality,

[1] Van Hook, in *Jour. Am. Med. Assoc.*, Feb. 20, 1897.

during the existence of which acute attacks are almost certain to occur. Adhesions may form as a result of appendicitis, general peritonitis may arise, the appendix may slough or become perforated, or abscess may ensue upon local peritonitis. Lymphangitis of the appendix may accompany, and septic phlebitis and abscess of the liver may follow, appendicitis. If a patient has once had appendicitis, he will always be liable to suffer from another attack if the appendix has not been removed. The liability becomes almost a certainty if the intestinal end of the appendix is narrowed or if the lumen is obstructed at any point, if a concretion exists, or if there is an area of ulceration or of desquamating epithelium. After an attack the appendix may remain enlarged and tender; exercise or indiscretion in diet may cause it to become tender, or the patient may have occasional attacks of colicky pain. If any of the above conditions exist, another attack may be confidently anticipated if operation is not performed. In such cases the appendix can usually be palpated. The method of palpation proposed by Robert T. Morris is very useful.[1] It is applied as follows:

The surgeon stands to the right of the patient and uses three fingers of the right hand to feel with and three fingers of the left hand to press with. Morris insists that no muscular effort should be used by the hand which feels. The feeling fingers are pressed by the other fingers beneath the margin of the right rectus muscle on a level with the umbilicus, and are drawn toward the patient's right side, and the colon will be felt to roll under the fingers. The process is repeated several times until the end of the cecum is reached. The appendix is sought for by rolling the cecum from side to side with the finger-tips, and working toward the proximal end of the appendix.[2]

Diagnosis.—The diagnosis is not invariably so certain as we might assume from some writings. Appendicitis may be difficult to diagnosticate from typhoid fever; suppuration or twisting of the pedicle of an ovarian cyst; extra-uterine pregnancy; stone in the kidney or ureter; empyema of the gall-bladder; hepatic colic; movable kidney; and, if the appendix lies posterior and against the outer layer of the mesocolon, perinephric abscess. acute intestinal

Treatment.—If the diagnosis were always certain from the beginning, and if the cases were seen at the very start by a surgeon, immediate operation in every case would be emi-

[1] See *Medical Record*, Sept. 17. 1898.

[2] Robert T. Morris, in *Medical Record*, Sept. 17, 1898.

nently proper. If this plan could be followed, the mortality from appendicitis would be extremely small. At this early stage the peritoneum is free from infection, and the appendix can be rapidly and easily removed without risk of infecting the peritoneum. Unfortunately, this plan cannot be habitually followed. As a rule, when the physician first sees the case the appendicular peritoneum is inflamed, and the surgeon usually sees the case at even a later period than the physician. At this time the barriers of leukocytes are being heaped up to limit the spread of infection, and delicate encompassing adhesions are usually being formed. Operation at this stage may be imperatively necessary, because of the rapid spread and dangerous nature of the process; but when operation is not done, in most cases at least a temporary limitation will be secured and the case will go on to an interval. Operation in this period is always dangerous; operation in an interval is safe. In many instances it is wiser to avoid operating when the case is first seen, and it is proper to wait for an interval. The period in which the surgeon usually sees the case for the first time is said by McBurney to be "too late for an early operation and too early for a late operation." Those who say, "operate as soon as the diagnosis is made," operate as a rule in this dangerous period, and in this period I do not believe that every case should be promptly cut. Many cases, it is true, must be operated on as soon as seen, irrespective of the duration of the disease. X We must operate promptly if the pulse is small and well above 100; if there is persistent vomiting; if there is delirium; if intestinal obstruction exists; if a chill has occurred; if the pain and rigidity are very marked; if a mass can be felt in the right iliac fossa or by rectal examination; if there is marked abdominal distention; if there are evidences of pus formation; if the patient is growing worse; if there is or has been shock; or if the pain suddenly passes away without the use of opiates.

In an ordinary mild case, in which none of the above named conditions or symptoms exist, it is best to defer operation. Those who advocate operating upon every case consider such delay reprehensible and dangerous, point out that even in apparently mild cases gangrene or perforation may quickly occur, and cite striking cases to emphasize their belief. There is much force in this view and it must not be hastily rejected. The choice, however, is not between a dangerous delay and a safe operation, but is rather between a dangerous delay and a dangerous operation. It is a question

of two dangers, and each side chooses the danger which seems to it the least. Richardson's elaborate study of 750 cases, showing a mortality of 18 per cent. in operations for acute appendicitis, determines us in the practice of the more conservative plan.

In an ordinary mild case of appendicitis the patient is purged by means of Epsom or Rochelle salt. This practice was begun because of the belief that inflammation of the appendix is associated with fecal impaction in the head of the colon. This belief has been exploded, but the treatment is still used, because experience shows that it is beneficial. If the condition of the stomach prevents the administration of salines, high enemas should be given.

Opium is never given. In the first place, it is not needed, for if the pain is so violent as to absolutely demand opium, operation should be performed. In the second place, opium masks the symptoms, makes the patient feel comfortable, and gives the physician an unfortunate and ill-founded sense of security. The pain about the umbilicus, if severe, can be distinctly and safely relieved, by the administration of thirty minims of chloroform every half hour until three doses are taken. When tenderness can be demonstrated in the right iliac fossa an ice-bag should be applied.

The case should be seen again within six hours. We are accustomed to follow McBurney's rule, which is as follows: If on seeing the patient again, six hours after the first visit, the patient is worse, operate at once. If he is no worse, there is no pressing danger.

If in twelve hours after the beginning of the attack the symptoms are not intensified, they will soon begin to abate; if the symptoms have become worse during this time, operate. If in twenty-four hours after the beginning of the attack the severity of the symptoms lessens, it is usually possible to wait for an interval; but if during the second twenty-four hours the abatement in the severity of symptoms has not gone on and there is doubt as to the condition, operate at once.[1] If operation is not performed, the patient is restricted to a liquid diet and the bowels are moved daily by salines.

If pus is present, some surgeons delay operation in the hope that firm adhesions will form around the pus, and that the necessary operation will simply be the opening of an abscess. I do not believe it is safe to delay operation in a pus case. The pus may become limited, but it may

[1] For McBurney's views, see *N. Y. Polyclinic*, January 15, 1897.

instead pass up toward the liver or down into the pelvis. Delay is fraught with peril.

When the attack has subsided, and about three weeks or more have passed, the appendix can be removed with remarkable safety. After a patient has had two or more attacks of appendicitis all surgeons agree that the appendix should be removed.

If only one attack has occurred, there may never be another, and the question arises, Should the appendix be removed after one attack? We do not know that a man has really recovered after purely medical treatment. Many cases reported as cured by medical means have subsequently required operation. As Lockwood puts it,[1] "To say that a man with appendicitis has been cured by medical means is in many cases equivalent to saying that a man with a stone in his bladder has recovered from calculus after the cure of a cystitis by rest in bed."

After a first attack if the appendix remains tender or becomes tender after exercise, or if attacks of colicky pain occur, operate.

In some cases a single attack of appendicitis is followed by persistent dyspepsia and ill health, and in such cases operation should be performed. In the majority of cases, after even one well-marked attack, operation is necessary (see Operation for Appendicitis).

Enteroptosis, or Glenard's Disease.—This disease is a prolapse of the intestine. It may be but a part of ptosis or prolapse of all the abdominal viscera; it may exist alone; it may be associated with movable kidney, prolapse of the stomach (gastroptosis), of the liver (hepataptosis), or of the spleen (splenoptosis).

In Glenard's disease the intestines occupy the lower portion of the abdomen, and the belly below the costal margins is flat, is dull on percussion, and the pulsations of the aorta are very evident. The right portion of the transverse colon begins to descend first, and other portions of the intestine follow. The victims of this disease are dyspeptic, anemic, and neurasthenic. The condition may arise without apparent cause, may be caused by wearing corsets, by falls, by blows, by lifting heavy weights, and by prolonged vomiting. The dyspepsia is due to dragging on the duodenum, the tube becoming flattened out (A. K. Stone). The flattening of the duodenum may be followed by kinking of the pylorus, and in such a case the stomach dilates, otherwise it is not dilated.

[1] *Brit. Med. Jour.*, January 27, 1900.

Treatment is medical unless the kidney, liver, or spleen is movable. Employ lavage, order a proper abdominal support, insist on regular exercise, and treat the anemia and dyspepsia.

The Peritoneum.

Acute Peritonitis.—Peritonitis, or inflammation of the peritoneum, is a common and important disease.

Aseptic irritation by a traumatism or a chemical irritant, produces aseptic peritonitis, a condition which is strictly limited; which may produce local pain and tenderness; which may cause aseptic fever from the absorption of fibrin-ferment and the products of tissue-change; which leads to the formation of temporary or permanent adhesions, and which is, in reality, a process of repair.

Peritonitis, as the term is used by the surgeon, is always due to bacteria. Bacteria may reach the peritoneal cavity by means of an abdominal wound or the entrance of foreign bodies; by extravasations from the stomach, bowel, vermiform appendix, gall-bladder, urinary bladder, kidney, Fallopian tube, or uterus, or by the passage of micro-organisms through the damaged walls of any of these viscera or structures; by way of an open Fallopian tube; from the breaking of an abscess into the peritoneal cavity; from areas of necrosis due to volvulus, strangulation, or intussusception of the intestine; twisting of the pedicle of an ovarian tumor, a floating kidney, or a floating spleen; blocking of a mesenteric vessel by a thrombus or an embolism; gangrene of the pancreas or spleen, and fat-necrosis.[1] In some cases the peritoneum may contain a point of least resistance, and bacteria contained in the blood reach this point and produce infection. It used to be thought that cold could produce peritonitis, but it seems probable that it can only act by producing an area of least resistance. The capacity of the rheumatic poison to produce peritonitis is doubtful.

The peritoneum is in reality a great lymph-sac, and, as Fowler points out, peritonitis is lymphangitis. "When the peritoneum is infected the lymphatics furnish an exudate which clots in the lymph-channels, blocks them, and limits or prevents absorption. This blocking of the lymph-channels serves to preserve the life of the subject, on the one hand; while a failure in this respect, either because of the enormous and overwhelmingly rapid increase of septic material and the large size and number of channels necessary to

[1] See Park's *Surgery by American Authors*.

destroy and obstruct, on the other hand, permits the destruction of the organism."[1] Absorption takes place most actively from the region of the diaphragm, hence a peritonitis in this region is peculiarly fatal. Absorption takes place very rapidly from the intestinal region, although not quite so quickly as from the diaphragmatic area. Absorption takes place slowly from the pelvic region, hence peritonitis of this region is much less dangerous than is the disease in the intestinal region, and vastly less dangerous than is the disease in the diaphragmatic region (Fowler).

Various bacteria may be responsible for peritonitis, especially staphylococci, streptococci, pneumococci, and colon bacilli. The infections which spread most rapidly and widely are due to streptococci. In streptococcus infection the protective exudate does not coagulate, barriers of leukocytes are not heaped up, encompassing adhesions do not form, there is rapid absorption of toxins, and overwhelming systemic poisoning. Colon bacilli cause a very grave form of peritonitis, but less rapid and diffuse than that caused by streptococci—in fact, the process is often encompassed for a time by coagulated lymph, leukocytes, and adhesions. The omentum particularly is thickened, and is apt to apply itself about the area of infection. Staphylococci and pneumococci produce peritonitis which is more apt to be limited than that produced by colon bacilli. In most cases of peritonitis a mixed infection exists; for instance, colon bacilli and staphylococci or colon bacilli and streptococci. In some apparently severe cases of acute peritonitis cultures have remained sterile.

Forms of Peritonitis.—An accurate bacteriological classification is not as yet possible.

Peritonitis can be named, according to regions, pelvic, subdiaphragmatic, etc.; it can be divided pathologically into diffuse septic, putrid, hemorrhagic, suppurative, serous, and fibrinoplastic (Senn); it can be classified, etiologically, into traumatic, puerperal, perforative, metastatic, etc.; and it can be divided, clinically, into circumscribed suppurative, general suppurative, and diffuse septic.

Circumscribed Suppurative Peritonitis.—In this condition, which is frequently met with in appendicitis, the area of infection is circumscribed by coagulated exudate, leukocytes, and adhesions, and an abscess forms. After a time distinct localization becomes evident.

The *symptoms* of circumscribed peritonitis are pain, at

[1] George R. Fowler, "Diffuse Septic Peritonitis," in *Medical Record*, April 14, 1900.

first general and then local, tenderness in a particular region, muscular rigidity, distention, vomiting, rapid and often wiry pulse, constipation, fever, great weakness, and dorsal decubitus with the thighs flexed. After a time a distinct mass can usually be detected by palpation, and there may be dulness on percussion, local rigidity, irregular temperature, sweats, and possibly edema of the belly-wall. An abscess, though limited for a time, is always liable to break through its walls and produce general peritonitis. Such an accident may be produced by muscular effort on the part of the patient or by injudicious palpation on the part of the surgeon; its occurrence is announced by shock, and the symptoms of general peritonitis quickly arise.

Diffuse septic peritonitis is apt to destroy life even before the peritoneum presents any marked change. Death ensues from the absorption of toxic alkaloids. Septic peritonitis may arise during puerperality, through lymphatic infection; it may be due to infection from without by an operation or an accident; to perforation of an ulcer; to gangrene of a portion of the intestine; to rupture of an abscess into the peritoneal cavity; or to migration of micro-organisms through a damaged wall of the bowel. Peritonitis due to perforation is called perforative peritonitis. Perforation is made manifest by a chill, shock, or rapid collapse. Gas may pass into the peritoneal cavity, and if it does so the area of liver-dulness is lessened or abolished. In true tympanites the liver is pushed up, but the area of dulness, though altered in position, is not decidedly lessened; symptoms and signs of hemorrhage may arise. Diffuse peritonitis is announced by a very rapid pulse, which is at first wiry and later gaseous; a temperature which may be at times febrile, but which is apt to be subnormal or which soon becomes so; pain, tenderness, dry tongue, delirium, persistent vomiting, constipation, and collapse. Rigidity may exist, and also intestinal obstruction; often, but not invariably, there is distention. In puerperal peritonitis or septic peritonitis from operation there is often no severe pain; in perforative peritonitis there is acute pain. Patients usually die within five or six days.

Diffuse suppurative peritonitis differs clinically from diffuse septic peritonitis in the fact that it is less apt to be fatal and widespread. In fact, adhesions may form about an area representing a considerable portion of the peritoneal cavity. The causes of both are identical. In septic peritonitis death occurs from absorption of toxins before obvious pathological changes occur in the peritoneum; in suppura-

tive peritonitis the microbes are fewer, are less virulent, or vital resistance is more decided, and suppuration follows marked changes in the peritoneum. In suppurative peritonitis the pyogenic bacteria are always present, and there exists in the peritoneum a wound or damaged area to constitute a point of least resistance.

Symptoms.—Chilliness or a rigor is common, followed by fever, the temperature rising to 102° or 104° F.; pain is intense, and is accentuated by motion and pressure; the attitude of the patient is assumed to relieve pain (he lies upon his back, with the shoulders raised and the thighs drawn up); there are vomiting, obstinate constipation, and rigidity of the abdominal walls, followed by distention when the intestine becomes paretic from septic poisoning. The pulse is rapid; is at first wiry, but may become gaseous. The constipation may be due either to tympanitic distention or to the shock and toxemia inhibiting intestinal peristalsis. Vomiting is frequent. In perforation gas often passes into the peritoneal cavity and obscures the liver-dulness; in tympanites without perforation the liver is pushed up and its dulness usually remains, but on a higher level. Pus unconfined by adhesions will gravitate to the most dependent part of the peritoneal cavity. In some cases of suppurative peritonitis there is no tympanitic distention or rigidity; in some cases there is no fever, and a subnormal temperature may even exist.

Treatment.—In the beginning of ordinary peritonitis without perforation give a saline cathartic, which will empty the peritoneal cavity of fluid, will favor the elimination of microbes, and will combat inflammation. The old-time remedy was opium, but Tait proved its inefficiency, and showed that it masked the symptoms and often created a false sense of security in the very midst of imminent dangers. The usual method of administering salines is to give ʒj of Rochelle salt and ʒj of Epsom salt every hour until a free movement occurs. This treatment will often cut short a beginning peritonitis, and will frequently prevent a peritonitis after an abdominal operation. Administer an enema of turpentine at the time the first dose of the saline is given. If this treatment fails, open the belly, explore for the causative condition, remedy it, if possible, wipe an infected area, flush with gallons of hot salt solution, and drain. In *perforative* peritonitis operate, *do not* give cathartics: they will only increase the extravasation and prevent its limitation by lymph. In typhoid fever it may be possible to anticipate perforation by the occurrence of leukocytosis. As soon as the patient

has reacted from the shock of the perforation perform a laparotomy, suture the perforation, wipe and flush out the belly, and drain. In cleansing, give special attention to Douglas's pouch, and to the space between the liver and diaphragm. In diffuse septic peritonitis open the abdomen in the middle line, explore for the source of trouble, and, if possible, remove it. Make an additional incision in the suprapubic region or through the right kidney pouch, or in the opposite side of the abdomen. It is frequently advisable to leave the abdominal wound open, and insert in it a piece of iodoform gauze. Flush with hot salt solution and drain. Some surgeons eviscerate and wipe the intestines with moist gauze pads. A circumscribed abscess is treated as follows: Open the abscess. It will be possible, if the abscess is adherent to the abdominal wall, to open the abscess directly without opening the peritoneal cavity. If this is not possible, after opening the abdominal cavity pack gauze pads in such a manner about the abscess as to prevent the diffusion of pus when the abscess is evacuated. After opening the abscess the primary lesion is sought for and, if possible, removed. The surgeon should not, in most cases, tear the lymph-barriers in an attempt to find the primary lesion, but should rather let it go undiscovered. Pack iodoform gauze against the intestines to reinforce the barrier of lymph and insert a tube. It is frequently advisable to leave the wounds open and drain with iodoform gauze. Every patient with peritonitis requires stimulants and frequent feeding with liquid food.

Tubercular peritonitis is seen by the surgeon as a primary local tuberculosis, though it occurs also as an associate of phthisis and as a part of a general tuberculosis. Tubercular peritonitis may be only a part of acute miliary tuberculosis. Peritoneal infection may follow a tubercular lesion of the intestine, the bacteria may enter by way of the Fallopian tube, the initial lesion may be tubercular appendicitis or tuberculosis of the mesenteric glands. The germ may enter in the blood or lymph. There are two groups of cases, the common chronic form and the rare acute condition. The acute form begins suddenly, and such cases, as pointed out by Lejars, resemble acute appendicitis. In either the acute or chronic condition it is frequently the case that pulmonary phthisis exists. There are three forms of chronic tubercular peritonitis: the ascitic, the fibrinoplastic, and the caseous,[1] although as a matter of fact these so-called forms are only stages of the same

[1] Parker Syms, in *Medical Record*, April 2, 1898.

disease. Tubercular infection may exist for some time without causing symptoms, and acute symptoms may suddenly arise or intestinal obstruction may occur from paresis of the intestine or catching of the gut under a band or adhesion.

Symptoms of Chronic Form.—Usually the disease begins insidiously. The digestion is found to be disturbed, the bowels are out of order, the abdomen is distended and tender, there is occasional colicky pain, and the patient loses flesh rapidly.

In many cases there is ascites, but the amount of fluid is rarely very great. In some cases the fluid is bloody. There is usually moderate fever, but there may be episodes of high fever and protracted periods of subnormal temperature, or the temperature may be slightly elevated in the evening and subnormal in the morning. When the temperature becomes markedly elevated, pain, tenderness, and distention notably increase. In some cases there is a continued fever resembling typhoid. Tumor-like formations may be detected. These formations may consist of indurated omentum, encysted exudate, or enlarged mesenteric glands.

In every suspected case a bimanual examination should be made under ether, in order to discover if there are any matted masses of intestine (Thomson).

In many cases a careful examination will detect tubercular disease of other regions of the body, particularly of the lungs. In some rare cases tubercular peritonitis undergoes spontaneous cure. In the vast majority of instances death ensues from the tubercular peritonitis directly or from associated or secondary disease in other organs.

If an intraperitoneal tubercular area caseates, a large cold abscess may form, and such an abscess may break into the intestine or may be opened externally, and may be responsible for the formation of a fecal fistula.

In a case of tubercular peritonitis intestinal obstruction may occur, the gut getting caught by bands or adhesions, or becoming a rigid tube because of the formation of tubercles.

Treatment.—In some cases medical treatment is of great service. The patient should be placed under proper hygienic conditions, nutritious food and tonics should be administered, the abdomen should be counter-irritated and massaged, and purgatives should be given frequently. Guaiacol applied daily to the abdomen is often of service. A mixture is made of 1 part of guaiacol and 5 parts of olive oil; ℨj of this mixture is rubbed into the abdomen, and the part is covered with a piece of flannel held in place by means of a binder. If medi-

cal treatment is not soon productive of benefit, an operation should be performed. It is a curious fact, but one confirmed by ample evidence, that simple abdominal section, without the introduction of germicides and without drainage, will cure at least 50 per cent. of the cases. The reason why operation cures is not known. It has been thought that the ascitic fluid is a culture-medium for bacilli, and when it is withdrawn the bacilli die, but opposed to this view is the fact that aspiration is rarely curative. It has been suggested that the operation brings numerous phagocytes to the peritoneum; that it stimulates vital resistance; that it leads to the exudation of antitoxic serum. The entrance of air seems to play a definite and important part in effecting a cure.

The ascitic cases are most frequently benefited by operation, and in these cases drainage is unnecessary. In encysted fluid operation usually cures.

In cases in which there are numerous adhesions the operation is not so likely to cure. Great care should be exercised in separating adhesions, because the bowel is apt to be torn and a fecal fistula may result. It may be necessary to separate adhesions to relieve obstruction. If operation is performed for cold abscess, tube-drainage must be used for some days. Operation should not be performed except to relieve obstruction or drain an abscess in a very advanced case, in a case with notably high temperature, or in a case with marked and advancing tuberculosis in another region.

Subphrenic Abscess.—A subphrenic abscess is a collection of pus beneath the diaphragm. The pus, as a rule, occupies a part of the lesser peritoneal cavity; in rare instances it is extraperitoneal (when it is of renal origin); in some cases it is contained in the area between the diaphragm, cardiac end of the stomach, and liver or spleen. It is an unusual thing for such an abscess to break into the general cavity of the peritoneum, but it may break into the pleural sac (Maydl).

Causes.—Perforation of a gastric ulcer, perforation of the gall-bladder or gall-ducts, ulceration of the duodenum, disease of the liver, spleen, pancreas, intestine, appendix, or kidney, hydatid disease, internal injury, metastasis, external injury, caries of rib, or disease of the pleura may be responsible for a subphrenic abscess (Maydl).

Symptoms.—There are the constitutional symptoms of suppuration and a swelling in the subdiaphragmatic region, these symptoms ensuing upon one of the causative conditions before mentioned. In many cases the abscess-cavity con-

tains gas as well as fluid. Empyema and subphrenic abscess resemble each other. In empyema the upper limit of the fluid is concave; in subphrenic abscess it is convex. In empyema the flow of pus through an aspirating-needle will be most marked during inspiration; in abscess, during expiration—the same is true of the rush of gas. In empyema the needle does not oscillate; in abscess it does.[1] The fact that an abscess contains gas is shown by the existence of a tympanitic percussion-note over a part of the cavity and an alteration in the area of tympany with an alteration in the position of the patient. An abscess of the liver does not contain gas and alters decidedly the outlines of the organ.

Treatment.—Incision and drainage. The incision in some cases may be made through the abdominal wall (epigastric region, iliac region, hypochondrium, or loin). In other cases the chest-wall is incised, a rib is resected, the pleura is opened, and the diaphragm is incised.

The Liver and Gall-bladder.

Rupture and Wounds of the Liver.—Rupture of the liver is due to very great force, and is usually accompanied by injury of other viscera. It is a very fatal accident, but an attempt should be made to save the patient by opening the abdomen and arresting hemorrhage. A wound of the liver causes violent hemorrhage which is usually rapidly fatal. Such a wound is apt to divide bile-ducts and allow of the escape of bile into the peritoneal cavity. Bile if sterile will do little harm, but if it contains organisms will produce a diffuse peritonitis. Patients do not always die from a serious traumatism of the liver. Some recover because operation has been performed. Some few recover without operation. This last fact is proved by reports of autopsies in which scars were found in the liver-parenchyma (Nussbaum). The fatality which usually ensues on a liver injury may be due to hemorrhage or peritonitis. If a surgeon is called to a patient suffering from wound of the liver, he must open the abdomen to arrest hemorrhage. In a penetrating wound, the wound in the abdominal wall must be enlarged in order to determine that the liver is wounded. If the left lobe of the liver is wounded, or if it is uncertain which lobe is wounded, the incision should be median. If the right lobe is wounded, make a curved incision along the line of the costal cartilages. In some cases these two incisions

[1] Wharton and Curtis, *Practice of Surgery*.

are joined.[1] The convex surface of the liver can be reached by Lannelongue's plan. Lannelongue resects the eighth, ninth, tenth, and eleventh costal cartilages and draws the ends of the ribs well out. When the wound in the liver is discovered and well exposed deep sutures of catgut should be inserted in the liver and the capsule should be stitched with fine silk (Schlatter). If sutures fail to arrest hemorrhage, the liver should be sutured to the belly-wall and the wound in the liver packed with iodoform gauze. It is useless to try packing without first attaching the liver to the abdominal wall, because pressure will simply push the liver away and will not stop the bleeding. The cautery is a very useful means of arresting bleeding. It should be avoided if possible in a large wound, because, even if it arrests primary hemorrhage, secondary hemorrhage may occur. After arresting hemorrhage wash out the abdomen with hot saline fluid, insert drainage, and close the abdominal wound. In a case of the author's in the Philadelphia Hospital the liver was wounded by the sharp ends of fractured ribs. The abdomen was opened, a wound was found, and bleeding was arrested by suturing the liver to the belly-wall and packing the wound. The patient died, and necropsy showed another wound on the posterior portion of the organ.

Hydatid cysts of the liver may be of small size and productive of no signs or symptoms; or may be of large size and productive of the signs of tumor. In the epigastrium the mass may be prominent and may fluctuate. In cyst of the right lobe the dulness is found in the axillary line and the growth encroaches on the pleura. In a large cyst fluctuation and hydatid fremitus may exist. Hydatid fremitus is a vibration imparted to the palpating fingers of one hand when the fingers of the other hand knock upon the cyst. There may be no discomfort produced by even a large cyst, but, as a rule, the patient suffers from a dragging sensation in the epigastrium and pressure-symptoms. Suppuration in the cyst produces the symptoms of abscess of the liver and septicemia. Rupture of the cyst produces shock, and even death. Rupture may take place into the pleural sac, the lung, or the peritoneal cavity. If the shock is recovered from, inflammation arises, the area of which depends upon the structures damaged. The escape of even a small quantity of hydatid fluid into the peritoneal cavity produces urticaria (hydatid toxemia). Aspiration for diagnostic purposes is not advisable.

[1] See Schlatter, *Beiträge zur klinischen Chirurgie*, Bd. xv., Heft ii., 1896.

Treatment.—Exploratory incision may be necessary to confirm the diagnosis, and the operation is completed at this time. After exposing the cyst it is packed around with gauze and a trocar is introduced. When the fluid is evacuated the sac is incised and is drawn partly through the wound in the abdominal wall, and is attached to the wound-margins (marsupialization). The endocyst can be removed by the hand or by irrigation. A large drainage-tube is introduced. If there is a considerable thickness of liver-tissue over the cyst, incise the liver with the cautery-knife.

Abscess of the liver is due to micro-organisms, especially staphylococci and streptococci. These organisms reach the liver by the general circulation, or, what is more frequent, are taken up from the intestinal tract and reach the liver by the portal circulation. The fact that abscess of the liver is in hot countries frequently preceded by amebic dysentery has lead to the presumption that amœba coli produces the abscess. This is not the case, and as a matter of fact the dysentery is due to bacteria (Zancarol). Habitual intemperance and constant overeating predispose to abscess of the liver. The disease may follow traumatism, dysentery, diarrhea, cholangitis, suppuration of a hydatid cyst, gall-stones, typhoid fever, appendicitis, and a chill to the surface of the body.[1] Abscess of the liver may be metastatic, and such abscesses are multiple. It may be caused by foreign bodies and parasites (Osler). A tropical abscess is an abscess of the liver in an inhabitant of a hot country. It is usually single, is frequently preceded by dysentery, and lasts from four weeks to several years.

Symptoms.—Osler tells us that the solitary abscess in rare instances produces no symptoms for a considerable time, death usually ensuing from rupture. As a rule, the liver is distinctly enlarged, tender, and painful. The pain usually persists, and is not strictly localized, but radiates to the right shoulder and back. An abscess at the surface causes more pain than an abscess deep within the organ. If the abscess is on the superior surface of the liver, respiration causes pain, and in some cases a friction-sound can be detected by auscultation. Pain is increased by pressure, coughing, and sudden or violent movement. The entire liver is enlarged. In some cases a hard and smooth area can be detected. Fluctuation can rarely be obtained. Jaundice does not occur unless the common duct is compressed or cholangitis also exists. The patient loses flesh; there is usually a septic

[1] G. B. Johnston, *Annals of Surgery*, October, 1897.

fever, with an evening rise and a morning remission, and a severe sweat as the temperature falls. In a very chronic case there may be no pyrexia. As a rule, the temperature resembles that of malaria and chills may occur. Sometimes it is like that of typhoid, with the exception that from time to time there are brief episodes of subnormal temperature. The appetite fails completely, the skin is of a pasty or dirty yellow, the patient lies upon the affected side, and if the liver becomes adherent to the abdominal wall there may be edema of the skin. Cough suggests that the abscess is on the convex surface of the liver, and such a cough is aggravated by recumbency. In some cases there is diarrhea, in others constipation. An abscess may lead to pyothorax, may break into the lung, may rupture externally, or into the bowel, stomach, or pericardial sac. In pyemic abscess the liver is enlarged and tender, there is slight jaundice, and the general symptoms of pyemia are present.

Treatment.—Make an exploratory incision. If the abscess is adherent to the parietal peritoneum, and is not covered by liver-substance, at once proceed to operation. If it is not adherent, or is covered by a considerable layer of liver-substance, stitch the visceral peritoneum to the parietal peritoneum and postpone further interference for forty-eight hours. The operation consists in evacuating the pus with a trocar and cannula, incising the abscess, stitching its edges to the edges of the abdominal wound, irrigating, and inserting a drainage-tube. If the abscess is covered by a layer of liver-tissue, after locating it with a cannula open into it with a cautery-knife and arrest hemorrhage by packing. When the parietal and visceral peritoneum are adherent, packing will arrest bleeding; if they are not adherent, packing will only push away the movable liver (John O'Connor). If pyothorax exists, resect a rib, open the pleural sac, and reach the abscess in the liver by an incision through the diaphragmatic pleura and the diaphragm (transthoracic hepatotomy). A pyemic abscess should not be operated upon unless it points, because in pyemia multiple abscesses exist.

Hepatoptosis, or Movable Liver.—This condition is very rare. It is due to relaxation of the supports of the liver. It may occur alone, but it is more often a part of a general abdominal relaxation or of Glenard's disease, and often the kidney is movable. The liver may descend into the lower abdomen, may be upside down (Demarquay), may rotate on its transverse axis (Griffiths), may be movable, or may be anchored by adhesions. In some cases the liver is

healthy and in some it is diseased. The liver is supported by ligaments and also by the vena cava (Faure), the abdominal wall, and the intestines (Glenard). The cause of the condition is in dispute. It can result from relaxation of the belly-wall, relaxation of the ligaments, enteroptosis, and great enlargement of the gall-bladder. It is most common in women, may be produced by tight lacing or strains, or the dragging of an adherent tumor. The condition is sometimes congenital.[1] Hepatoptosis is readily diagnosticated. In most cases the shape, the movability, and the absence of the liver from its proper position are diagnostic. Even when the organ is dislocated and attached it is missed from its proper abode.

Treatment.—By the use of an elastic support. If this fails to give relief, open the abdomen and fasten the liver to the abdominal wall (hepatopexy). Ramsay rubbed the upper surface of the liver with gauze to promote adhesion, and transfixed the round ligament with a suture, which was also carried around the cartilage of the seventh rib. Richelott, Areilza, and Treves have operated for this condition.

Gall-stones.—Gall-stones are formed during life in the gall-bladder or bile-ducts by the agglutination of materials which have precipitated from bile. The nucleus of a gall-stone may be a mass of bacteria, a blood-clot, epithelium, crystals of cholesterin or carbonate of lime, or a cast of a small duct.[2] The condition of the body which leads to the formation of gall-stones is designated by the term cholelithiasis (Brockbank). But one stone may be present or great numbers may exist. Solitary stones may be nearly round or cylindrical. When several stones or many stones exist the mutual pressure often leads to the formation of facets (Naunyn). In color calculi may be pale yellow, green, black, or brown. Some are heavier than bile and some are lighter. Brockbank gives the following varieties of gall-stones: pure cholesterin stones, stratified cholesterin stones, common or gall-bladder calculi, mixed bilirubin calcium calculi, pure bilirubin calcium calculi, and certain rare forms.[3] Gall-stones usually take origin in the gall-bladder, but may arise in the common duct, the cystic duct, the hepatic duct, or the smaller ducts of the liver. As a rule, however, calculi in the common or cystic duct were not formed there, but were transported from the gall-bladder or hepatic ducts.

[1] See Terrier and Auvray, in *Rev. de Chir.*, August and Sept., 1897, an article I have freely used.

[2] Bevan, in *Chicago Med. Recorder*, April, 1898.

[3] Brockbank's treatise on *Gall-stones.*

Causes.—The cause is a catarrhal condition of the bile-ducts, due particularly to the entrance of bacteria from the intestine (colon bacilli, typhoid bacilli, pus organisms, pneumococci). This catarrhal condition causes stagnation of bile.

The chief predisposing causes are advancing years, insufficient exercise, the consumption of an excess of nitrogenous food, gouty tendencies, conditions which interfere with the emptying of the gall-bladder, cardiac disease, and cancer of the liver. The disease is more common in the insane than in the mentally sound, and in women than in men. The special liability of women may be brought about by tight lacing, pregnancy, inactivity, or movable right kidney. There are two forms of the condition to be considered. The acute type, due to efforts made by the gall-bladder or duct to expel the concretion; and the chronic condition, in which a calculus is lodged for a long time, or in which, as soon as one calculus is passed into the intestine, "another begins its journey" (Brockbank). The fact that bacteria cause the condition must not lead us to infer that pus is formed. The bacteria are present in small numbers or else their virulence is greatly mitigated, they produce only catarrhal inflammation, quantities of cholesterin are secreted, the bile stagnates, and a stone forms. In many cases the stone or stones never cause trouble. A very small stone usually passes freely, A larger stone in passing causes colic. A still larger stone remains in the gall-bladder, or becomes fixed in the cystic duct or the intestinal outlet of the common duct.

Symptoms.—The formation of a stone requires several months, and during the antecedent period of gastro-intestinal catarrh, "the prodromal state" of Kraus, certain symptoms usually exist, viz.: constipation, flatulence, loss of appetite, migraine, uneasy sensations in the epigastrium or right hypochondrium, sallowness of the skin, slight yellowness of the conjunctivæ, scantiness of urine, which excretion is saturated with uric acid, and may after a time contain a little bile. If this condition is not arrested by treatment, it grows worse. The abdomen becomes decidedly distended; pressure over the stomach or liver may cause distinct uneasiness, or even pain; acid indigestion is very troublesome, violent attacks of migraine occur, constipation becomes more decided, the feces become clay-colored, gastralgia may occur, the skin is apt to be slightly jaundiced, itching is complained of, the patient is irritable and sleeps poorly. The liver is found to be enlarged, and the urine contains distinct amounts of bile. When the patient reaches this stage gall-stones are very

liable to form. These symptoms may pass away even if a concretion forms. It is quite true that in some cases a stone exists for years without causing trouble; but, as a rule, it greatly aggravates the condition. When a stone forms pain is apt to become a marked feature of the case. A sense of pressure or of soreness in the hepatic region has added to it sudden and transient paroxysms of pain, due to the passage of thick bile from the gall-bladder and small ducts, or of gravel from the small ducts urged on by bile-pressure. When a stone begins to pass from the gall-bladder violent colic is experienced. Such a colic usually comes on very suddenly, and often about three hours after a meal. It may, however, come on gradually, the patient complaining greatly of flatulence. The pains are violent, spasmodic, and paroxysmal, and over the hepatic and epigastric regions, "radiating upward over the right half of the thorax" (Kraus). The patient is profoundly nauseated, and usually vomits, the abdomen is distended, and a condition almost of collapse is soon reached. The attack lasts a variable time, and terminates by the stone passing into the intestine or falling back into the bladder. After its conclusion, if the feces are examined carefully during several days, the stone may be discovered. The fact that no stone is discovered does not prove that no stone was passed, because a cholesterin stone will be destroyed in the intestinal canal. Jaundice almost invariably follows the attack in about twenty-four hours and lasts several days. If the stone is impacted, after a time the pains become less violent, but again and again the patient suffers from aggravation of them. An individual may get about with impacted stone, but again and again fierce attacks of colic occur, and if the stone is in the common duct the patient becomes and remains deeply jaundiced. In certain cases attacks of gall-stones are accompanied by febrile seizures resembling malaria.

If a stone lodges in the cystic duct, it does not cause jaundice. It grows in size from incrustation, prevents the entrance of bile into the gall-bladder, and the bladder becomes filled with mucus (hydrops of the gall-bladder). If a bladder so blocked becomes infected, pus forms, and the condition known as empyema of the gall-bladder exists. An empyema of the gall-bladder may rupture into the bowel, the peritoneal cavity, or even through the skin.

If a stone blocks the common duct, jaundice always exists. Blocking may be complete, and the stone may ulcerate into the bowel or the peritoneal cavity. Blocking may be incom-

plete, the stone acting as a ball-valve and producing intermittent colic and jaundice (Christian Fenger). Fenger points out that if a stone remains fixed in the common duct the liver becomes tender and enlarged; but if a stone floats about in the common duct, the gall-bladder undergoes atrophy. In complete obstruction the stools become clay-colored and bilirubin is found in the urine.

Gall-stones may lead to suppurative inflammation of the gall-bladder or bile-passages, ulceration, occlusion of the neck of the gall-bladder, dilatation of the stomach from the formation of adhesions which kink the pylorus, abscess, peritonitis, empyema of the gall-bladder, and cancer of the gall-bladder. If the patient develops distinct infection of the gall-bladder or bile-ducts, he will suffer from chills, fever, and sweats.

Gall-stones may lead to cancer of the gall-bladder, and cirrhosis of the liver. A stone may ulcerate into the bowel and cause intestinal obstruction. It may be difficult to make a diagnosis between gall-stones with icterus and cirrhosis of the liver with icterus. In the former case the urine contains bilirubin and in the latter case urobilin.

Treatment.—In the prodromal stage and after recovery from an attack insist on the patient taking considerable outdoor exercise. Direct him to take a cold sponge-bath every morning, to move the bowels freely every day, and to employ a simple diet. The patient should avoid all highly seasoned foods, pastry, rich soups, fatty food, cheese, alcohol, and sweets. Alkalies internally are of value.

During the attack give an enema, apply hot turpentine stupes over the hepatic region, and give a hypodermatic injection of morphin and atropin. If vomiting does not occur, let the patient drink a large amount of warm water to favor it. After the attack administer a purgative.

When the attack has terminated examine carefully for any evidence of inflammatory trouble in the hepatic region.

In certain cases operation becomes necessary. Mayo Robson advises operation in the following cases:[1] in frequently recurring biliary colic without jaundice, whether the gall-bladder is enlarged or not; in cases of enlargement of the gall-bladder without jaundice, even if there is no pain; in persistent jaundice which was ushered in by pain, painful seizures occurring, whether or not febrile attacks occur; in empyema of the gall-bladder; in peritonitis beginning in the gall-bladder region; in intrahepatic abscess and in abscess

[1] Mayo Robson on the *Gall-bladder and Bile-ducts*.

about the liver, gall-bladder, or bile-ducts; in some cases where the stones have been passed, but adhesions remain and produce pain; in fistula cases; in some cases of persistent jaundice due to obstruction of the common duct, although there may be a possibility of cancer existing; in phlegmonous cholecystitis and gangrene of the gall-bladder. Besides these conditions which may be produced by gall-stones, Robson operates for wounds of the gall-bladder, rupture of the gall-bladder, infective and suppurative cholangitis, and for some conditions of chronic catarrh of the bile-ducts and gall-bladder.[1]

The common operation is cholecystotomy, which consists in opening the gall-bladder, removing the stones, and making a fistula of the gall-bladder (page 853). The fistula is permitted to heal, hence we say cholecystotomy rather than cholecystostomy. The operation of incision, removal of the stone, and suture of the gall-bladder is known as cholecystendysis. If calculi exist in the common duct, it may be possible, after celiotomy, to manipulate them back into the bladder. In some cases cholecystotomy is performed, or a fistula is made, and the duct and bladder are frequently irrigated. In other cases the stone may be crushed by the fingers manipulating the duct and the concretion within it (choledocholithotrity). The duct may be opened, and after the removal of the stone closed by sutures (choledochotomy). If the stone is impacted near the outlet of the duct, the duodenum is incised and the stone removed (choledocho-duodenotomy). A dilated bile-duct may be anastomosed to the bowel (choledocho-enterostomy) or to the surface (choledochostomy). The obstruction may be side-tracked by anastomosing the gall-bladder to the bowel (cholecystenterostomy) (p. 854), or a dilated duct to the bowel (choledocho-enterostomy). In some cases the gall-bladder is removed (cholecystectomy). Cysticotomy is incision of the cystic duct.

The Pancreas.

Hemorrhage.—Multiple minute hemorrhages into the pancreas produce no definite symptoms, and may occur in purpura and in scurvy. Fatal pancreatic hemorrhage may be the "terminal condition or event" in acute pancreatitis or in cancer of the pancreas.[2] Anders points out that not only

[1] Robson's treatise, from which the above is taken, is a valuable exposition of the surgery of the gall-bladder and bile-ducts.

[2] J. M. Anders, paper read before *Amer. Med. Assoc.* in 1899.

may pancreatic hemorrhage result from, but it may be followed by acute pancreatitis. It may arise when there is fat-necrosis, or after traumatism. Pancreatic hemorrhage is a recognized cause of sudden death. The symptoms may arise without warning. They comprise severe pain, nausea, vomiting, abdominal tenderness, distention, great restlessness, constipation, and collapse. The blood may collect in the lesser peritoneal cavity, or about the spleen and left kidney (Prince and F. W. Draper). It may be possible in some cases to arrest the hemorrhage by operative procedures.

Acute Pancreatitis.—Hemorrhagic pancreatitis is an inflammation of the fibrous and fatty interstitial tissue (Fitz), and occurs in people in middle life, and especially in tipplers. It begins suddenly: there are violent pain, nausea and vomiting, moderate fever, constipation, distention, and rapid collapse (Reginald Fitz, and Osler and Welch). Inflammation of the pancreas with pus-formation is, as a rule, more chronic. The symptoms of both conditions are similar at the beginning of the attack, and if pus forms a septic fever develops. In some cases the pancreas becomes gangrenous.

The real cause of sudden death in acute pancreatitis has been much disputed. In one of Anders's cases the amount of blood lost was only eight ounces, and yet death occurred. It has been suggested that death is due to pressure upon the semilunar ganglia by the enlarged organ and consequent cardiac paralysis (Friedreich). It seems likely that death is due to shock (Prince).

Treatment.—In view of the difficulty of distinguishing acute pancreatitis from intestinal obstruction and perforated ulcer of the stomach, in any case where either of these conditions is suspected an exploratory laparotomy is indicated. Osler speaks of cases of hemorrhagic pancreatitis in which operation was followed by recovery.

Cysts of the pancreas are most common between the ages of twenty and thirty, and occasionally follow injury. They are due, as a rule, to obstruction of the orifice of the common duct or of the pancreatic duct by calculi, tumor-pressure, or cicatricial contraction. These cysts may grow rapidly or slowly. They usually produce considerable pain and gastro-intestinal disturbance, and may be accompanied by changes in the feces, mental depression, and diabetes. Examination of the abdomen discovers a mass which is usually median, is elastic, and is dull at some parts but resonant at others (where it is crossed by the colon). In some cases the

mass fluctuates. The fluid of the cyst is apt to contain urea, and will convert starch into sugar.

Treatment.—Tapping is contraindicated. It might do much damage. In Keen's case, if an aspirating-needle had been introduced it would have perforated both walls of the stomach. Confirm the diagnosis by an exploratory incision. It may be possible to extirpate the cyst, but it is better to incise it, stitch its edges to the belly-wall, and drain.

The Spleen.

Wounds and Rupture.—A wound of the spleen causes great hemorrhage, and if no surgical aid is offered will rapidly produce death. The treatment consists in celiotomy and splenectomy.

Rupture of the spleen produces the signs and symptoms of intra-abdominal hemorrhage. The blood clots so rapidly that it gathers in the left loin, and is not commonly diffused throughout the abdomen. Certain recognition of the condition may require exploratory celiotomy. If such a condition is suspected while intravenous saline transfusion is being employed, the surgeon opens the abdomen, and if the spleen is ruptured, removes it.

Abscess of the spleen is a rare condition which is metastatic in origin. Pain is felt, and enlargement is noted in the splenic region, and the symptoms of pyemia exist. The treatment consists in incision and drainage.

Wandering Spleen.—The spleen may wander into any part of the general peritoneal cavity. This condition is seldom met with except in women. It is most common in women who have borne children (J. Bland Sutton). A wandering spleen may undergo atrophy, engorgement, or axial rotation (J. Bland Sutton). The organ, when displaced, drags upon the stomach, producing dilated stomach; it may interfere with the bile-duct, causing jaundice; it may cause intestinal obstruction by forming adhesions, or may cause uterine retroflexion or prolapse by passing into the pelvis.

J. Bland Sutton says this condition may endanger life, as it may lead to rupture of the stomach, intestinal obstruction, splenic abscess, or splenic rupture.[1] A wandering spleen can be identified by the fact that it has a notch upon its edge, and can be pushed about the abdomen. When this condition exists the spleen may be missed from its normal

[1] *British Medical Journal*, Jan. 16, 1897.

situation. Always examine the blood in order to determine if leukemia or malaria exists.

Treatment.—Greiffenhagen advocates suturing the organ in place (splenopexy). Most surgeons prefer to perform splenectomy. In a case without leukemia the operation is very successful. Splenectomy in wandering spleen is rarely followed by serious blood-changes or other trouble. The reason is that a wandering spleen is usually a diseased organ, having undergone hypertrophy or fibroid change, and other structures have taken on splenic function. Splenectomy should not be undertaken if leukemia exists. In such a case apply a support and employ medical treatment for the existing disease.

Operations upon the Abdomen.

Abdominal Section (*Celiotomy; Laparotomy*).—Before opening the abdominal cavity for exploratory purposes or to gain access to some area of abdominal or pelvic disease, the patient is carefully prepared as for any other operation. In an appendicitis case the patient is moved with the utmost care and is prepared for operation most gently, because of the possible danger of rupturing an abscess. In an emergency case no prolonged or complicated method of cleansing can be employed. The abdomen and loins are scrubbed carefully with soap and water, special attention being given to the umbilicus, the pubes are shaved, the soapsuds are washed away with sterile water, the surface is gently scrubbed with alcohol and then with a hot solution of corrosive sublimate (1 : 1000), and covered with gauze wet with the sublimate solution. Whenever there is time it is eminently desirable to prepare the patient the day before. The instruments required depend upon the nature of the case. As a rule, there are required scalpels, scissors, a dry dissector, two pairs of dissecting-forceps, hemostatic forceps, pedicle-forceps, Hagedorn needles, calyx-eyed intestinal needles, a needle-holder, drainage-tubes, gauze pads, gauze for sponging, silk, catgut, silkworm-gut, the Paquelin cautery, an electric light, also an instrument-bag and a saline solution for hypodermoclysis or intravenous infusion. Always count the instruments, sponges, and pads, and write down the number, and count them again after operation. This rule is adopted so that no instrument, sponge, or pad will be left in the abdomen. The abdominal pads and sponges are not used when dry. Dry sponges injure the peritoneum and favor the subse-

quent development of adhesions (Sanger). The pads and sponges should be wrung out in hot normal salt solution before using.

Operation.—An anesthetic is given. In some cases the patient is placed recumbent, in others is put in the position of Trendelenburg (Fig. 270). The patient is to be carefully protected from cold, the extremities and the chest are covered with blankets, and sterilized sheets are placed well around the field of operation. The parts are sterilized anew immediately before operating. The surgeon steadies the skin of the belly with the fingers of his left hand, and, holding the knife in the right hand, makes an incision about two inches long. This incision is often made in the middle line midway between the pubes and umbilicus; but may be in the semilunar line, in the epigastric region, or in some other situation. The first cut goes to the aponeurosis. Clamp the vessels. Do not hunt for the linea alba below the umbilicus, but go right through or between the recti muscles. Above the umbilicus the linea alba is very distinct and the surgeon often cuts through it. Divide the transversalis fascia, beneath which is a little fat, and expose the peritoneum. The latter structure is recognized by its glistening appearance, by the ease with which it can be pinched up between the finger and thumb, and by the readiness with which its opposed surfaces may be made to glide over each other. On identifying the peritoneum, catch it at each side of the incision with forceps, raise a fold, nick it with a knife, and open it with scissors to the length of the external wound. To prevent stripping of the peritoneum a good plan is to anchor it to the belly-wall with a stitch on each side of the incision. Through the wound thus made the abdomen and its contents are explored, the trouble located, and determination made as to whether or not further operation is advisable, and, if it is advisable, what form it shall take. It may be necessary to enlarge the wound. This is done by placing the index and middle fingers of the left hand in the belly, with their pulps against the peritoneum, in the line where the surgeon will cut, to serve as supports to the scissors and as guards to intraperitoneal structures. The scissors are introduced and the wound is enlarged upward, around the umbilicus if necessary. As soon as the incision is complete it is a good plan to push a large pad into Douglas's pouch

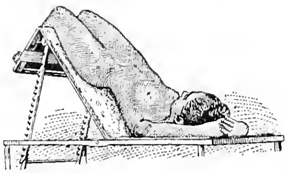


FIG. 270.—The Trendelenburg position.

and leave it there until the operation is finished, when it must be removed. Slender adhesions are broken off with the finger or are pushed off with gauze; firm adhesions are tied in two places and cut between the ligatures.

The toilet of the peritoneum is important after the operation is completed. Following a clean laparotomy, when but little blood has flowed into the cavity, flushing is not required; if much blood has flowed or if septic matter has passed into the peritoneal cavity, after removing the sponge from Douglas's pouch flush the belly thoroughly with hot normal salt solution, empty out most of the fluid, but let a pint or more remain in the abdomen. The retention of saline fluid in the belly minimizes shock. It is absorbed with great rapidity after the operation if the patient is placed with his head lower than his feet, because in this position the saline fluid gravitates to the diaphragmatic region, where absorption is very active. If there is widespread infection, eviscerate, wipe out the peritoneum with pads soaked in hot normal salt solution, and wipe the intestines carefully, slowly returning them as they are wiped. Extravasated septic matter is apt to collect in the peritoneal fossæ and between the liver and diaphragm, and these regions must be carefully wiped or irrigated. In some cases it is desirable to drain through a lumbar incision. Rutherford Morrison has pointed out that on the right side a lumbar opening into the right kidney pouch will drain a fossa which holds over a pint of fluid, and which, when the patient is recumbent, is the most dependent portion of the peritoneal cavity. In some cases a drainage-opening is made on each side of the belly or above the pubis, or through the vagina. In septic cases it may be advisable to drain with several pieces of iodoform gauze instead of inserting tubes. Before closing the wound arrest hemorrhage and count the instruments and sponges. In most instances drainage is not needed, but it must be used in septic cases and when hemorrhage has been severe. We may drain by a rubber tube, strands of gauze, or a glass tube. If a glass tube is used, it is introduced at the lower angle of the wound and reaches the bottom of the pouch of Douglas. This tube is repeatedly emptied during the progress of the case by means of a syringe. In closing the wound some surgeons close the peritoneum with a continuous catgut suture and close the belly-wall with interrupted sutures of silkworm-gut; some operators close with interrupted silkworm-gut sutures, including peritoneum, muscles, and skin in each stitch. When

passing the sutures have a gauze pad under the wound and be very careful not to include bowel or omentum. It is necessary to tighten and tie most carefully to prevent omentum being caught in the loop of the stitch. In badly infected cases the wound is often kept open. Dress with aseptic gauze and wood-wool, and apply a flannel binder.

Operation for Acute Appendicitis.—Before operating try to locate the situation of the appendix, and the relation the area of infection bears to the ascending colon. The incision should be over the seat of disease. In the rare left-sided cases and in median cases the incision is on the left side or median. In some cases where the appendix is posterior the cut may be in the loin. In one case, I opened a purulent collection through the rectal wall. In the vast majority of cases the incision is made in the right iliac region.

In acute appendicitis when there is not thought to be a distinct abscess the incision usually made is two inches internal to the anterior superior iliac spine and perpendicular to a line drawn from the spine to the umbilicus (Fig. 271). The skin incision is usually three inches in length, the upper third of the incision being above the omphalospinous line; the incision in the peritoneum is from two to three inches in length, but if there are many adhesions it may be necessary to make it much longer. The oblique incision may be carried out as advised by McBurney. An oblique incision in this situation cuts very few nerve-fibers, and hence is not followed by marked muscular wasting, a condition which strongly predisposes to hernia. Further, as Van Hook points out,[1] the oblique incision enables the surgeon to reach freely all the ordinary areas of appendix trouble, the wound is parallel with the lines of traction of the abdominal muscles and does not tend to gap widely. After opening the peritoneum examine very gently to detect the situation of the appendix, and if there are or are not adhesions. In a very recent case and in a very acute case there will probably be no adhesions unless there have been previous attacks. Surround the region of infection with strips of iodoform gauze, each strip being two and one-half inches wide, fifteen inches long, and four layers in thickness. The edges of the wound should be lifted up by retractors and the strips inserted around the cut, between the parietal peritoneum and intestines and to a distance of three inches from the wound. Strips of gauze are passed, when possible, below the appendix to prevent entrance of infected material into the

[1] *Jour. Amer. Med. Assoc.*, February 20, 1897.

pelvis, and a piece is pushed upward toward the liver (Van Hook). Over the iodoform gauze which it may be necessary to leave in place after the operation, gauze pads are packed. The appendix is sought for by finding the colon. The colon is found by following the parietal peritoneum with the finger. The course of the finger is first outward, next backward, and finally inward; the first obstruc-

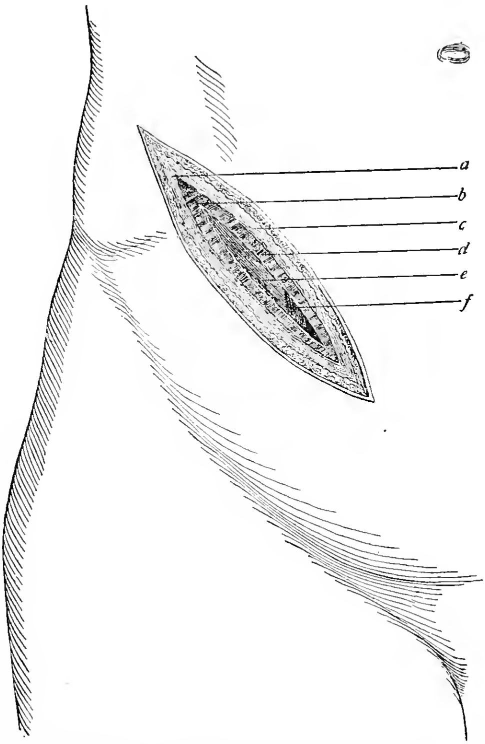


FIG. 271.—Resection of the vermiform appendix, incision through the abdominal wall (Kocher): *a*, external oblique muscle; *b*, internal oblique muscle; *c*, aponeurosis of external oblique; *d*, aponeurosis of internal oblique; *e*, peritoneum; *f*, outer border of rectus abdominis muscle (under it the deep epigastric vessels).

tion it encounters is the colon. The fact that it is the colon can be confirmed by finding the longitudinal band. The longitudinal band leads directly to the appendix. Pass the finger down to the head of the colon, find the appendix, usually posterior and internal, and lift it and the head of the colon into the wound. In some cases it will be advisable to deliver the head of the colon from the belly; in other cases

this will not be necessary. If adhesions exist, they must be gently and carefully broken down. In most cases the meso-appendix and neck of the appendix are tied with two strong 1
silk ligatures (Fig. 272), are cut off below the ligatures, and the stump of the appendix is cauterized with pure carbolic acid

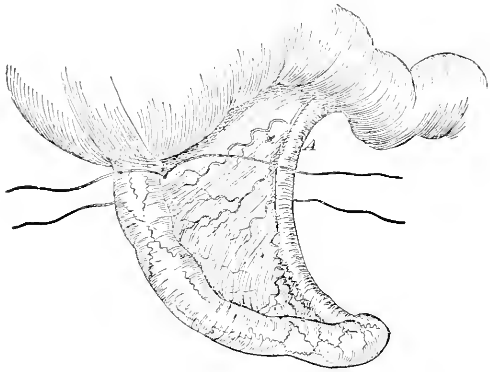


FIG. 272.—Ligation of appendix and meso-appendix.

and is inverted into the coats of the colon by Lembert sutures. An excellent method is to turn up a cuff of peritoneum, pull down the other coats, ligate at the base, cut through the 2
tube, let the musculomucous stump retract, and tie or suture the peritoneal cuff over the stump. This plan was devised by Barker (Fig. 273). Another method is to encircle the appendix with a ligature, as is shown in Fig. 272, pass the second ligature through the meso-appendix at x, tie both ligatures, cut off the appendix and meso-appendix below the threads, suture the fringe of the meso-appendix, 3
and cauterize and invert the stump of the appendix. Some remove the appendix by an elliptical incision around its base, and close the colon- 4
wound by Lembert sutures. Some surround the base of the diverticulum with a purse-string suture, cut off 5
the appendix close to the colon, invaginate the stump into the lumen of the colon, tie the purse-string suture, and suture the peritoneal surfaces of the colon together. If there is no pus or no extravasated feces, if the peritoneum is not seri-

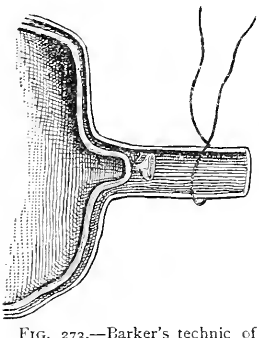


FIG. 273.—Barker's technic of operation for removal of the appendix.

ously affected, if the appendix is not gangrenous or perforated, and if there is no pus within the appendix, remove the pads, irrigate with hot salt solution, remove the strips of gauze, and close the wound. If any of the above conditions were found, remove the infected pads, but leave the iodoform strips in place to limit infection and secure drainage. Pass sutures through the wound-edges, tie some of the sutures and leave some untied until the gauze is removed at a later period (Van Hook).

If an operation is performed in a distinct interval, pus is absent and the surgeon can proceed without apprehension. If there is any question of the presence of pus, surround the region with gauze, as suggested above, before breaking down adhesions and liberating the appendix. An interval operation should not be performed until three weeks after an attack. In an interval case McBurney proceeds as follows: he makes the skin incision in the direction of the fibers of the external oblique muscle, separates the fibers of this muscle by blunt dissection, retracts them, separates the fibres of the internal oblique and the transversalis muscles in the same way and retracts them, and opens the transversalis fascia and peritoneum. No muscle-fibers are cut, and hernia is not apt to follow. Such a wound is closed as follows: a continuous catgut suture for the peritoneum, sutures of kangaroo-tendon for transversalis fascia, the muscles are restored to place, and the skin is closed by a subcuticular stitch.

If an *abscess* is believed to exist, make an incision parallel with Poupart's ligament and over the area of dulness on percussion (Willard Parker's oblique incision). If the abscess is adherent to the anterior abdominal wall, such an incision will not enter the free peritoneal cavity. If after opening the abdomen an abscess is thought to exist, although it is not adherent to the anterior abdominal wall, surround the abscess with gauze before opening it, as directed under acute appendicitis. This gauze is placed under the margins of the incision in the peritoneum all around the appendix area; a piece is carried toward the pelvis and another piece toward the liver. Overlay this gauze with gauze pads (Van Hook). Adhesions are broken through with the finger, and when pus appears it is at once wiped away. Remove the appendix in most cases, but not in all. If the appendix lies loose in the abscess-cavity, if it is sloughed off or but loosely attached to the abscess-wall, remove it. If the appendix is firmly fixed in the abscess-wall and must be dug out of a mass of inflammatory material, do not remove it. To remove it under these circum-

stances may rupture the wall and disseminate the pus into regions not protected by pads and gauze. Deaver, Murphy, and others tell us to always remove the appendix. We do not believe this to be a safe rule to follow. To insist on removing the appendix may cause death. When the appendix is left it usually sloughs away. It is true a fecal fistula may result, but this usually heals spontaneously. Even if a fecal fistula forms and does not heal, the surgeon may have acted properly in not removing the appendix, because a fecal fistula may be remedied by another operation. It is rarely that secondary abscess forms, and there are not a great many cases recorded in which an appendix has subsequently given trouble when left after operation. " When Deaver decides to remove such an appendix he makes an incision in the median line of the abdomen, packs around the periphery of the abscess with gauze, opens the abscess by another incision, disinfects, inserts drainage, and then removes the surrounding gauze and closes the median incision." Irrigation should not be employed in appendicular abscess. The force of the stream may break down barriers of lymph and spread infection. After the evacuation of the pus, whether the appendix was removed or not, take out the pads, but leave the long strands of iodoform gauze in place (Van Hook). Introduce iodoform gauze into the abscess-cavity and insert a rubber tube, partially suture the wound, and dress with dry gauze. In forty-eight hours all the gauze is removed and fresh pieces are inserted for drainage. After this period the gauze drain is changed daily. An interval case should be up and about in from ten days to two weeks after operation. An abscess case may require a much longer time for complete recovery. A fecal fistula sometimes results in cases in which the appendix was not removed, and occasionally forms when it was removed. Morris maintains and proves that these large pieces of iodoform gauze sometimes cause intestinal obstruction and sometimes iodoform-poisoning, but the risk, it seems to us, should be taken.

Enterorrhaphy, or Suture of the Intestine.—Surgical opinion has greatly altered in regard to this operation since the day when John Bell wrote his famous attack on Benjamin Bell. John Bell said: "If in all surgery there is a work of supererogation, it is this operation of sewing up a wounded gut." To-day we know that if in all surgery there is a proceeding of imperative necessity, it is the sewing up of a wound in the intestine. To perform this operation take fine sterile silk and thread a thin, round, straight calyx-

eyed needle with it (Fig. 274). This needle is very useful, as it can be threaded rapidly by pushing the calyx eye down upon the silk thread while the latter is kept taut. *Lembert's suture* (Fig. 275, A) is at right angles to the wound. It goes down to, but not through, the mucous membrane. It is formed by picking up a fold of the intestine (one-twelfth to one-eighth of an inch wide) one-eighth of an inch from the edge on one side of the wound, passing the needle

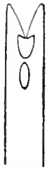


FIG. 274.—Eye of the calyx-eye needle.

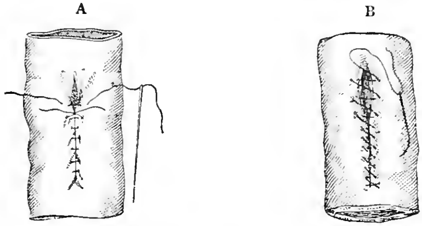


FIG. 275.—Enterorrhaphy: A, Lembert's suture; B, Dupuytren's suture.

through, picking up a fold on the opposite side of the wound, and passing the needle through. On tying the threads the serous membrane is inverted and peritoneum is brought into contact with peritoneum. For many years it was taught that this suture should include only the serous coat, but Halsted, in 1887, showed that it must include the tough submucous coat. The submucous coat is strong, and wild hold a suture. The other coats are thin, tear easily, and

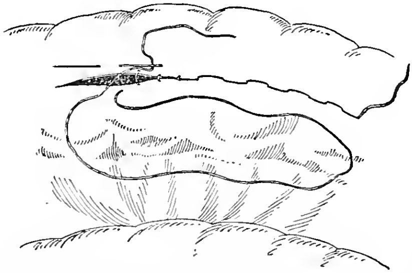


FIG. 276.—Cushing's right-angled suture (Senn).

will not hold a suture. So thin are the coats that a surgeon could not suture the serous coat alone were he to try. Sutures which include only the muscular and serous coats tear out easily. *Dupuytren's suture* (Fig. 274, B) is simply a continuous Lembert suture running obliquely across the wound. *Cushing's right-angled suture* (Fig. 276) is a continuous suture

catching up the submucous coat and serving to invert the serous layer. Ford of San Francisco employs a continuous inversion suture, which is tied in a single knot each time it is

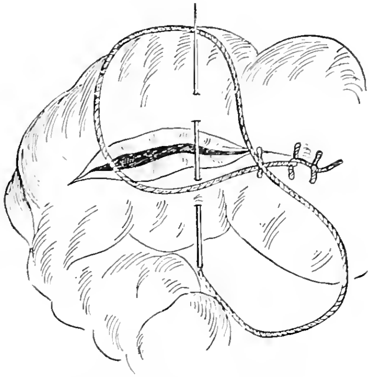


FIG. 277.—Ford's stitch, showing a Lembert insertion and the needle passed so as to tie a single knot by drawing it on through.

drawn through (Fig. 277). Downes of Philadelphia uses a similar stitch. Halsted's mattress or quilt suture is shown in Fig. 278. Each stitch picks up the submucous coat. Mattress sutures do not tear out easily, they oppose evenly considerable surfaces, and do not constrict the tissue as much as Lembert stitches. The *Czerny-Lembert suture* is a suture passed through the serous membrane on one side of the wound, made to perforate the mucous membrane, and to emerge at a corresponding point of the serous membrane. A Lembert suture is added (Fig. 279). As at present used, the Czerny suture is carried to, but not through, the mucous membrane. Gussenbauer's is similar to the Czerny-Lembert suture, except that it applies the Czerny and the Lembert with one suture, and this suture does not pass through the mucous membrane (Fig. 281). *Wölfler's suture* unites broad layers of the serous coat, the knots being tied internally (Fig. 282). Senn says that after suturing a large wound of the stomach or of intestine a strip of omentum ought to be laid

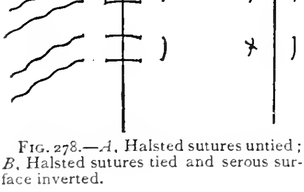


FIG. 278.—*A*, Halsted sutures untied; *B*, Halsted sutures tied and serous surface inverted.

over the wound and fastened by catgut sutures (omental graft). These grafts adhere and are a safeguard against leakage. For other methods of enterorrhaphy, see Intestinal Resection and Anastomosis.

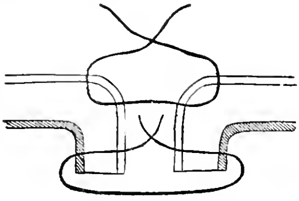


FIG. 279.—Czerny-Lembert suture.

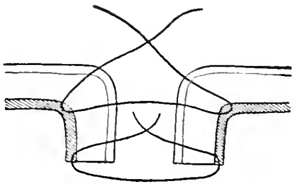


FIG. 280.—Czerny-Lembert suture as at present used.

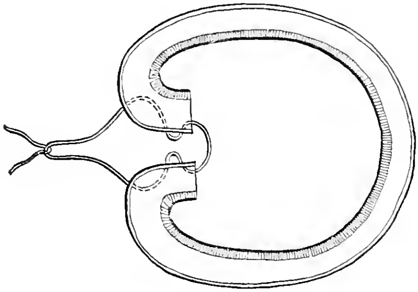


FIG. 281.—Gussenbauer's suture.

Digital Dilatation of Pylorus for Cicatricial Stenosis (Loreta's Operation).—For a week before operation feed the patient by way of the rectum, and supplement rectal feeding by the stomach administration of peptonized milk. Wash out the stomach once a day. A few hours before operation wash out the stomach again. Place the patient recumbent and administer ether. Make a vertical incision in the linea alba. The incision begins one inch below the ensiform cartilage and should be five inches in length. When the peritoneum has been opened the stomach is drawn out of the wound, any adherent omentum is separated, and the pylorus is carefully examined. The stomach, after being surrounded with gauze pads, is opened near the center of its anterior surface, "but rather nearer to its pyloric end" (Jacobson).

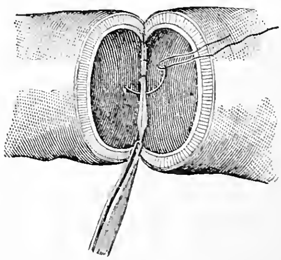


FIG. 282.—Wölfler's suture.

Insert the index-finger through the stomach wound and into the pylorus, and follow that with the middle finger. The pylorus can be well dilated by separating the fingers. If the stenosis is so tight as to prevent the entry of a finger, first introduce a pair of hemostatic forceps and open the blades a little when they are within the lumen of the constricted area. The wound in the stomach is closed by a continuous silk suture of the mucous membrane and two layers of Halsted sutures, to invert and approximate the peritoneal surfaces. After closure of the stomach wound the abdominal wound is sutured.

Pyloroplasty (Heineke-Mikulicz Operation).—Prepare the patient as for Loreta's operation. Open the abdomen in the middle line. Draw up the pylorus as well as possible and pack hot moist gauze pads around it; make an incision through the stricture and in a direction corresponding to the long axis of the stomach and bowel. Catch an aneurysm-needle under the upper margin of the incision and draw it up, and an aneurysm-needle over the lower margin and draw it down. The effect of traction is to convert the transverse wound into a vertical one. The sutures are applied so as to maintain the wound in a vertical line. The mucous membrane is sutured with a continuous suture of silk, and interrupted Halsted sutures of silk close the peritoneal and muscular coats.

Pylorectomy (Excision of the Pylorus).—The removal of a portion of the stomach is a partial gastrectomy, and pylorectomy is a partial gastrectomy in which the pylorus is removed.

This operation, which was first performed by Péan in 1879, is done for cancer of the pylorus. In most cases of pyloric cancer the abdomen is opened after a palpable tumor is detected, and when a palpable tumor is detectable it is usually too late to perform pylorectomy.[1]

Keen agrees with Hemmeter that stenotic symptoms, even when no tumor is palpable, call for exploratory laparotomy; if the stomach is dilated, if there is cachexia, if there is no free hydrochloric acid in the gastric juice, if there is an excess of lactic acid in the gastric juice, if the patient is at or beyond forty years of age, when there is vomiting of blood, when the Oppler bacillus is present, when blood examination shows a diminution in red corpuscles and hemoglobin, and also shows that there is no increase in white corpuscles after a full meal. After the abdomen has been opened the stomach

[1] Keen's *Cartwright Lectures* for 1898.

is examined, and if a tumor exists the surgeon must decide between the performance of pylorectomy and gastro-enterostomy. If the tumor is not very extensive, if there is no glandular involvement or only involvement which can be removed, and if adhesions are not extensive, pylorectomy is chosen, otherwise gastro-enterostomy is selected.

Even in favorable cases the mortality from pylorectomy is over 25 per cent. Prepare the patient for pylorectomy as for Loreta's operation. The best incision through the abdominal wall is transverse over the middle of the tumor. A small incision is made first to permit of exploration, and if the growth is found to be removable the incision is enlarged. The center of the incision is over the most prominent part of the tumor, and the direction of the incision corresponds with the long axis of the pylorus. Draw the tumor into the wound, and tuck pads about the stomach and the pylorus to catch extravasated fluids. Free the pylorus; incise between forceps the great omentum near the greater curvature of the stomach, and ligate each end in segments; treat the lesser omentum in the same manner. Each omentum is divided only to an extent sufficient to permit removal of the growth. Repack the gauze pads and tie a rubber tube around the duodenum below the growth. In making the excision remember that the stomach-wound will be much larger than the duodenal wound, and a special method of suturing will be required to approximate the two wounds in size. The lines of incision are shown in Fig. 283. The stomach is cut with scissors until two-thirds of its depth is divided, and the organ is washed out. After stopping hemorrhage this cut is closed by a continuous suture for the mucous membrane and by Halsted sutures for the other coats. The remaining portion of the stomach is cut through. The duodenum is cut through its upper half below the growth, and is fastened to the stomach by Halsted sutures at the upper border and Wölfler's sutures at the posterior borders. Wölfler's sutures are applied from inside, they pierce all coats, and bring broad layers of the serous coat into apposition. The remainder of the duodenum is cut through, and its anterior and inferior parts are united to the stomach by a double row of Halsted sutures, as set forth above (Fig. 283). Stitch the edges of the cut omenta to the stomach, cleanse the

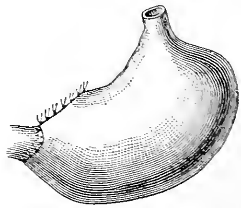


FIG. 283.—Pylorectomy.

parts, replace the stomach, insert gauze for drainage, close the abdominal incision, and dress the wound. Drainage is necessary after any extensive operation upon the stomach because there is great danger of extravasation, this danger being due, as Richardson shows, to the difficulty of making a tight approximation and to the action of the gastric juice.[1] Another method of performing pylorectomy is to excise the growth as directed above, suture the opening in the stomach, and implant the duodenum in the anterior or posterior wall of

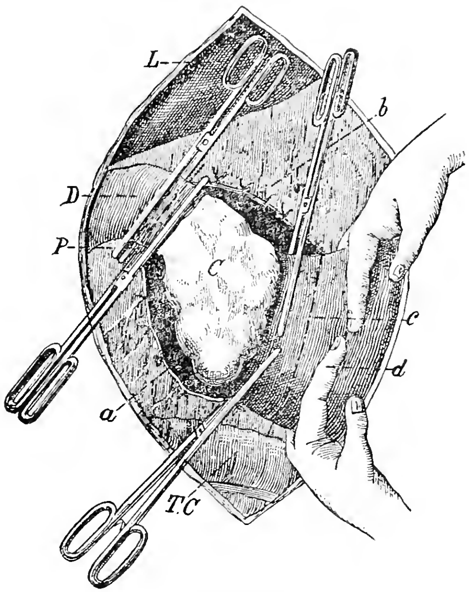


FIG. 284.—Kocher's method of pylorectomy: *L*, liver; *D*, duodenum; *P*, pylorus; *C*, carcinoma; *T C*, transverse colon; *a*, separation-place of the ligature gastrocolicum; *b*, separation-place of the lesser omentum; *c*, separation-line of the stomach; *d*, place where the stomach is kept closed by the middle and index fingers.

the stomach, making an incision through the stomach-wall to permit of it. Kocher advocates implantation of the duodenum in the posterior wall of the stomach. Kocher's method of pylorectomy is shown in Figs. 284, 285. The junction between the duodenum and the posterior wall of the stomach may be effected by a large Murphy button. Give nothing by the mouth for twenty-four hours after the performance of pylorectomy. Thirst can be relieved by enemata of water or by the hypodermatic injection of boiled water. After

[1] M. H. Richardson, in *Boston Med. and Surg. Jour.*, August 4, 1898.

twenty-four hours begin with stomach feeding, starting with dessertspoonful-doses of peptonized milk every hour.

Total Gastrectomy.—The entire stomach was first removed by Conner of Cincinnati. The first successful operation was performed by Schlatter of Zurich in 1898. Total gastrectomy will rarely be required, but in certain unusual cases it will be proper to perform it. In some cases the duodenal end can be sutured to the divided esophagus; in others it will be necessary to close the end of the divided

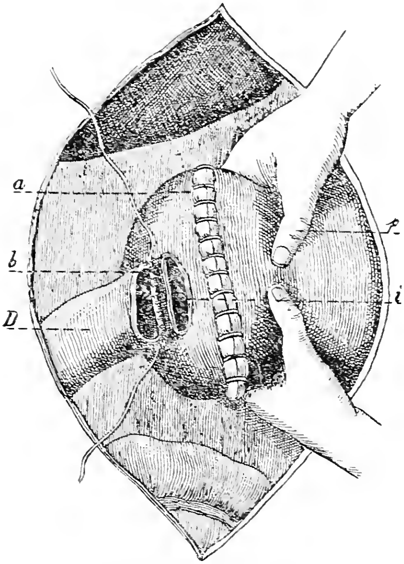


FIG. 285.—Kocher's method of pylorectomy: *D*, duodenum at the posterior wall; *a*, continuous suture of the peritoneum; *b*, posterior line of peritoneal continuous suture of the ring; *p*, assistant's thumb pressing the stomach against the duodenum so as to close its lumen; *i*, incision in the posterior gastric wall.

first portion of the duodenum, and anastomose the esophagus to the third portion of the duodenum.

The cases suitable for total gastrectomy are those in which the entire viscus, or almost the entire viscus is cancerous, the stomach being still freely movable, and the glands not so much implicated as to forbid attempts at removal. It is a remarkable fact, first demonstrated in Schlatter's case, that an individual can digest food very well without a stomach.

Gastrotomy.—This term is used to designate the operation of opening the stomach for the accomplishment of some purpose, and immediately closing the incision in the gastric

wall when that purpose is accomplished. Gastrotomy may be performed to permit of the removal of foreign bodies, of exploration of the stomach and its extremities, of divulsion of the pyloric orifice, of the treatment of an esophageal stricture, or a stricture of the cardiac orifice of the stomach, or of the removal of a foreign body lodged in the esophagus.

The patient is prepared as for pylorectomy. The incision may be vertical in the middle line or identical with the incision for pylorectomy. If a large foreign body can be felt, the incision is made directly over it. When the peritoneal cavity is opened the surgeon decides as to the point where the stomach is to be incised, and draws this portion out through the wound, packing gauze pads under and around it. The stomach is opened by means of scissors, the cut being at a right angle to the long axis of the viscus (Jacobson). Bleeding vessels are ligated with catgut. The purpose for which the stomach was opened is now to be carried out, the interior of the stomach and the surface of the extruded portion are irrigated with hot salt solution, the mucous membrane is sutured with a continuous suture of silk and two rows of Halsted sutures are inserted. The abdominal wound is closed without drainage.

Gastrostomy is the making of a permanent gastric fistula, through which opening the patient can be fed. The operation is employed in cases of esophageal obstruction or obstruction of the cardiac end of the stomach. In many cases of malignant disease the operation is performed too late, and if performed when the patient is greatly emaciated and exhausted the operation has, of course, a high mortality. An early operation is far safer and confers the maximum of relief. The operation should be performed, as Mikulicz advises, when the patient is steadily losing weight and there is beginning to be difficulty in swallowing semi-solids or liquids. The surgeon must endeavor to perform an operation which will not permit of leakage. Prepare the patient as for gastrotomy. In Witzel's method an incision is made four inches long, running to the left from the middle line, just below the border of the ribs. After opening the peritoneal cavity seize the stomach, bring it out of the wound, and pack gauze around it. Introduce a rubber tube into the stomach and enfold it by a double row of Lembert sutures (Figs. 286, 287). This tube should be five inches long and of the same diameter as a No. 25 French bougie. The opening is made in the stomach toward the cardiac extremity, the tube is placed parallel with the belly-wound, and the outer end of the tube emerges in

the median line. The stomach is returned, and is stitched by three sutures to the abdominal wall. The tube is retained in place by a catgut stitch through the wall of the tube and the stomach-wall. The abdominal incision is sutured and a clamp is placed on the tube. When the patient is fed a funnel is slipped into the tube, the clamp is removed, and liquid food is poured into the funnel. After the wound heals it is not necessary to permanently retain the tube. It is passed

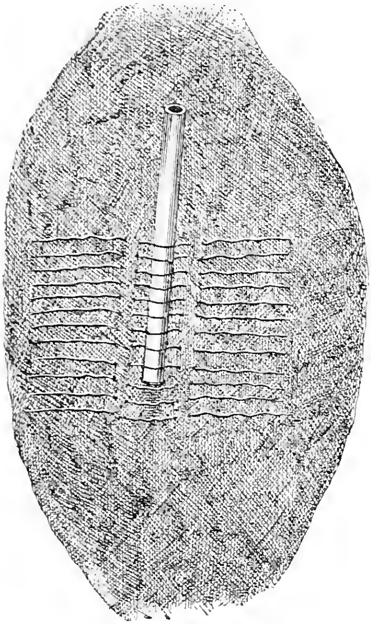


FIG. 286.—Witzel's method for gastrostomy, showing application of sutures in wall of stomach, embedding tube obliquely therein.

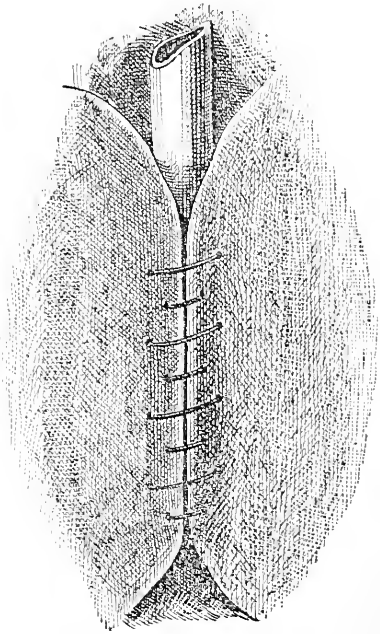
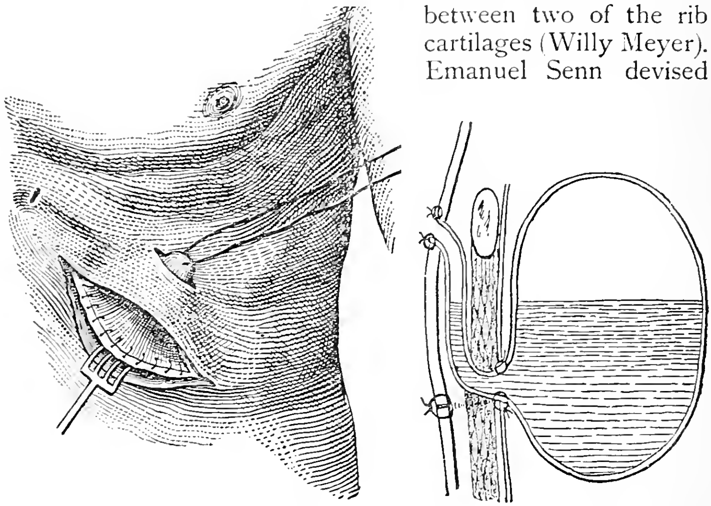


FIG. 287.—Sutures tied, completely embedding tube for some distance.

when the patient desires food. Kader has modified Witzel's method. A small incision is made in the stomach and a tube is introduced. Two Lembert sutures are passed so as to form a fold on each side of the tube and turn the stomach-wall inward around the tube. Lembert sutures are inserted in the furrow on each side of the tube. Two more folds are formed over the first two. The stomach-wall is stitched to the parietal peritoneum and sheath of the rectus muscle (Willy Meyer). The Ssabanejew-Frank operation is preferred by many surgeons. Fenger's incision is made (a curved incision

at the margin of the costal cartilages of the left side). A cone of the stomach is pulled out of the wound and is passed under a bridge of skin which has been prepared for it. The stomach is fixed above the margin of the ribs and opened (Figs. 288, 289). Van Hacker makes the gastric fistula through the left rectus muscle, and Hahn between two of the rib cartilages (Willy Meyer). Emanuel Senn devised



FIGS. 288, 289.—Frank's method of gastrostomy in carcinoma of the esophagus.

the following method: a cone of the stomach is pulled out of the abdominal wound, and this cone is puckered by the insertion of two drawing-string sutures of chromic catgut through the serous and muscular coats. A cuff of gastro-colic omentum is sutured by silk around the neck of the puckered cone. The stomach is sutured to the belly-wall with silk, the sutures, including the omental cuff, the serous and muscular coats of the stomach, and the structures of the belly-wall, except the skin. The skin is partly sutured. The stomach may be opened at any time.

Gastro-enterostomy or **gastro-jejunostomy** is the establishment of a permanent fistula between the stomach and the small intestine, in order to side-track the pylorus. The operation is performed for cancer of the pylorus, for non-cancerous stenosis of the pylorus, and in some cases of ulcer of the stomach. Gastro-enterostomy was first performed by Wölfler in 1881. In non-malignant conditions the mortality is very low (about 4 per cent.), the hyperacidity of the gastric juice disappears and the functions of the

stomach are restored. In malignant cases the mortality is higher, but even in such cases life may be prolonged and made comfortable for months by the operation. Before operating the stomach must be irrigated as before pylorectomy.

Anterior Gastro-enterostomy.—In Senn's method of operation a median incision is made through the abdominal wall, from below the xiphoid cartilage to the umbilicus. An opening is made in the stomach in the direction of the long axis of the viscus and its edges are stitched with a continuous catgut suture. The contents of the bowel are forced along to below the point where an incision is to be made; a rubber tube is fastened around the bowel above this point, and another below it; an incision is made in the long axis of the bowel, and the margins of the wound are sutured in the same manner as the stomach-wound. Bone plates are introduced into the stomach and intestine, and the ligatures are tied as in intestinal anastomosis. Catgut rings or rubber rings may be used. Fig. 290 shows Wölfler's method of gastro-enterostomy. Kocher's method is as follows: after opening the abdomen, lift up the omentum, pull up a loop of intestine and find the point where the jejunum appears from under the mesocolon. Select a loop sixteen inches from the origin of the jejunum and prepare to attach it to the stomach. Wölfler showed that the intestine should be applied to the stomach in such a manner that the direction of peristalsis in the bowel must correspond to the direction of the stomach-tide. This can be accomplished by having the proximal portion of gut to the left, and the distal portion to the right. The operation is to be so performed that after its completion the stomach-contents pass into the distal portion of the gut, and the intestinal contents do not tend to enter the stomach (Fig. 293). In order to accomplish this Kocher hangs the intestine to the stomach-wall in such a manner that the proximal portion of the loop is posterior and ascending, and the distal portion is anterior and descending. The bowel is hung to the stomach by a continuous serous suture of silk, the ends of which are left long. The intestine is opened by a curved incision, the convexity of which is downward. The stomach is opened so that the convexity of the cut is upward. The valve-like pro-

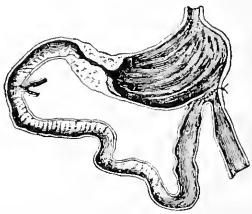


Fig. 290.—Gastro-enterostomy (after Wölfler).

tion of the bowel-wall is sutured to the stomach below the incision in that viscus. The two openings are well approximated by sutures. In some cases after the performance of gastro-enterostomy fluid from the stomach gathers in the

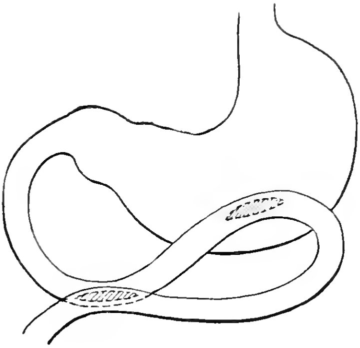


FIG. 291.—Jaboulay's method of gastro-enterostomy.

proximal loop and persistent vomiting of bile occurs. This condition is very serious and often fatal, and may be due to bending or twisting of the distal loop, to failure of peristalsis in the proximal loop, or to contraction of the stomach incision.[1]

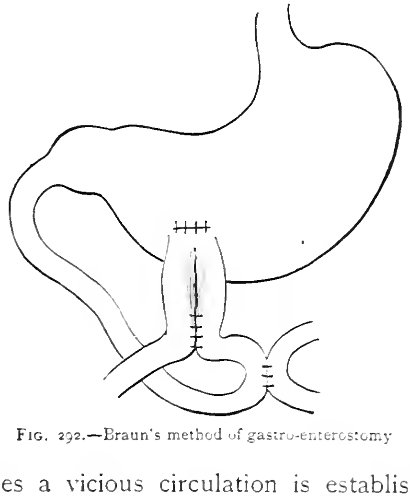


FIG. 292.—Braun's method of gastro-enterostomy

In some cases a vicious circulation is established, some or all of the stomach contents passing through the fistula and

[1] Chlumsky on gastro-enterostomy in the Breslau clinic. Article by Charles L. Gibson, in *Annals of Surgery*, August, 1898.

into the proximal loop. The above condition can be corrected or prevented by performing an anastomosis between the two loops (Figs. 291, 292). It is stated that such unfortunate conditions do not follow posterior gastro-enterostomy, and are rare after the Wölfler-Lucke operation (Fig. 293).

Posterior gastro-enterostomy is performed as follows: after the abdomen has been opened the stomach and omentum are raised; a portion of the upper jejunum is seized, emptied, and tied with tubes as previously described. A spot is selected on the transverse mesocolon where there are no vessels and an opening is made through the mesocolon with a dry dissector. The posterior wall of the stomach is

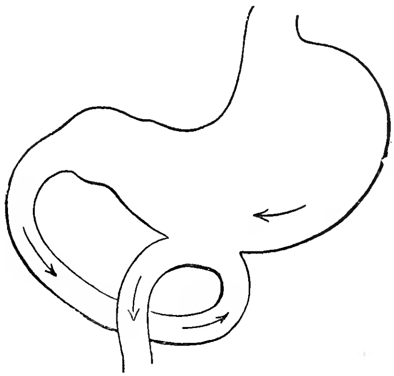


FIG. 293.—Wölfler-Lucke method of gastro-enterostomy

pulled into the opening and sutured to its edges. An anastomosis is then performed.

Gastro-enterostomy may be quickly performed by the use of a large-sized Murphy button. Murphy says that in some reported cases the button has slipped back into the stomach, but this accident can be prevented by the use of an oblong button and by making the anastomosis on the posterior stomach-wall. The same surgeon advises us to scarify the peritoneum to hasten union, and says supporting sutures about the button are not required, except when considerable tension exists. There is no question that an anastomosis on the anterior wall, accomplished by a Murphy button, can be speedily performed. Anastomosis on the posterior wall cannot be performed speedily, and it sacrifices the great advantage of the button operation—that is, speed.

In spite of the reported cases, we can truthfully assert that the danger of the button producing grave trouble is slight.

Gastrogastrostomy is an operation performed for hourglass contraction of the stomach, a condition which occasionally ensues on the healing of an ulcer. In this operation an anastomosis is effected between the pyloric and cardiac ends. Wolfe, Watson, Wölfler, and Eiselberg have performed this operation. Weir and Foote maintain that double gastroenterostomy, "tapping each sac," is a preferable procedure.[1] In some cases an operation identical with pyloroplasty can be performed (incision of the constriction in the direction of the long axis of the stomach and suturing vertically).

Gastroplication (Brandt's Operation of Stomach-reefing for Dilated Stomach).—Apply sutures in the anterior wall so as to form reefs, then tear through the great omentum and apply sutures in the posterior wall. The sutures pass through the serous and muscular coats. A continuous suture may be used on the anterior wall and another on the posterior wall, or numerous interrupted sutures may be inserted. This operation is of questionable value, and must never be used if stenosis of the pylorus exists, and stenosis of the pylorus is the most common cause of gastric dilatation.

Gastropexy (Duret's Operation).—It has been shown by Duret that dyspepsia of a peculiarly severe type may be produced by prolapse or downward displacement of the stomach. In this condition he advises the following operation: perform a median laparotomy, but do not incise the peritoneum in the upper portion of the wound. Expose the stomach and fix it by means of a silk suture to the undivided but exposed peritoneum. The suture should be parallel to the lesser curvature and near the pylorus should be horizontal.[2]

Duodenostomy and Jejunostomy.—It has been suggested that one of the above operations should be performed in cases of pyloric obstruction in which pylorectomy is not feasible.

Jacobson disapproves of both procedures, and objects particularly to duodenostomy, because it involves a fixed portion of the intestine which is difficult to deal with, and because important fluids escape constantly from the fistula.[3]

[1] F. S. Watson, in *Boston Med. and Surg. Jour.*, April 2, 1896; Weir and Foote, *Medical News*, April 25, 1896.

[2] *Rev. de Chir.*, June, 1896.

[3] Jacobson's *Operations of Surgery*.

The same author objects to jejunostomy because of the inevitable leakage of nutritive fluids.

Reported cases of jejunostomy do not indicate that the operation prolongs life to any considerable degree.

Enterectomy, or Resection of the Intestine with Approximation by Circular Enterorrhaphy.—After opening the abdomen isolate the loop of intestine it is intended to resect. Push a rubber tube through the mesentery close to the bowel, above the seat of operation, and pass a rubber tube through the mesentery below the seat of operation. Empty this segment of bowel by squeezing and stroking, tighten the rubber tubes, and clamp them to keep the bowel empty (Fig. 294). Instead of tubes, strips of iodoform gauze may be used to encircle the bowel. The diseased intestine is resected, each incision being carried through a healthy segment. The lumen of each end of the divided gut is irrigated with salt solution. The divided surfaces are approximated by a double row of sutures—a continuous suture for the mucous membrane, and Lembert's, Dupuytren's, or Cushing's suture to effect inversion. Thoroughly satisfactory approximation can be effected by one row of Halsted sutures. If a redundant fold of mesentery is left, it can be stitched at its raw edge (Fig. 295). Many surgeons remove a V-shaped piece of mesentery and tie the divided mesenteric vessels (Fig. 294). The tubes are removed, and the wound is cleansed, closed, and dressed.

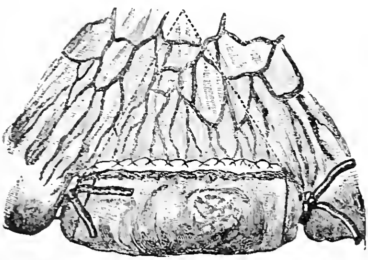


Fig. 294.—Excision of bowel: first step (Esmarch and Kowalzig).

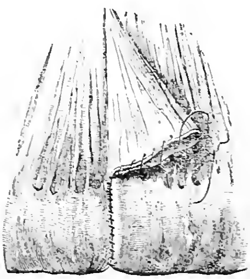


Fig. 295.—Excision of bowel with enterorrhaphy and stitching of the redundant mesentery: second step (Esmarch and Kowalzig).

Senn effects invagination by means of a bone ring (Fig. 297).

If the two segments of bowel are unequal in size, the narrow part of the bowel should be cut obliquely and the larger part should be cut transversely. To meet this com-

plication Billroth devised lateral implantation. Suppose the cecum has been resected: its lower end is closed by Lembert sutures, an opening is made in the long axis of the periphery of the colon opposite the attachment of the mesocolon, and the end of the ileum is sutured into this incision.

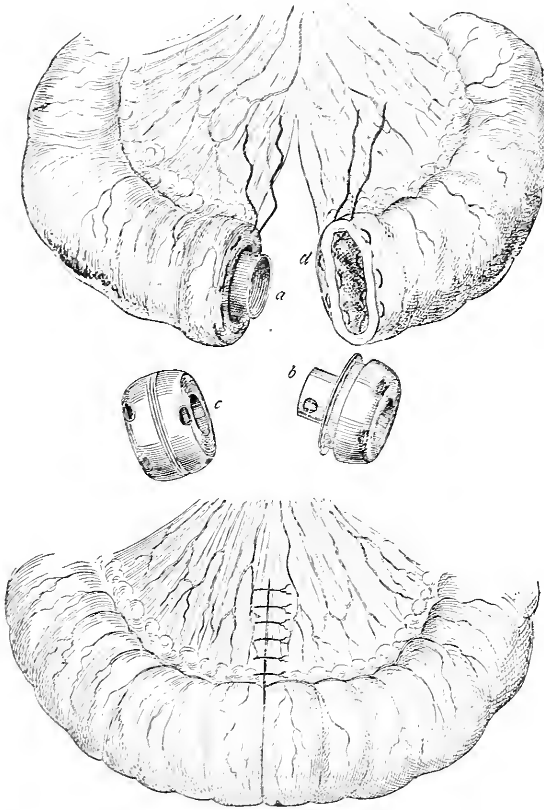


FIG. 296.—Resection of intestine; *a*, *b*, the two halves of the button; *c*, the two portions clamped together; *d*, introduction of the sutures for holding each half of the button in place. The lower figure shows the completed union of the intestine by the Murphy button; the slip in the mesentery has been closed by linear union (after Zuckerkandl).

Senn advises the insertion of an anastomosis-ring in the ileum, the invagination of the colon as the ring is pulled into place, and firm suturing of the line of junction. By Senn's method the ileum may be implanted into the end of the colon or into a slit in the wall of the large bowel after the end of the colon has been closed. In some cases, where one portion of bowel

is larger than the other, lateral anastomosis is the preferable method. For a full week after an intestinal resection the patient is fed chiefly by nutrient enemata. During the first twenty-four hours nothing is given by the stomach but bits of ice, and for the next six days but a very little liquid food is allowed to be swallowed.

The use of Murphy's button permits of rapid approximation after resection (Fig. 296, *c*). This button closely approximates the portions of the intestine within its bite, rapid adhesion taking place. The diaphragm of tissue undergoes pressure-atrophy, and liberates the button, which is passed per anum. It is claimed that the button-opening contracts but slightly. For end-to-end or side-to-side approximation of the small

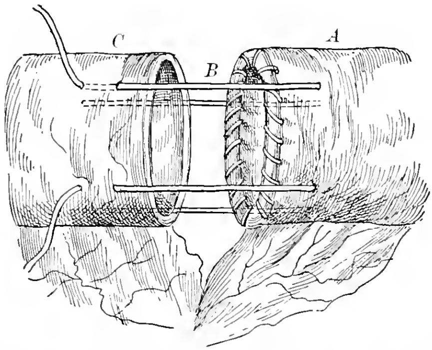


FIG. 297.—Senn's modification of Jobert's invagination method; *A*, upper end lined with ring; *B*, invagination sutures in place; *C*, lower end.

intestine a No. 3 button is used. For similar operations on the large intestine a No. 4 button is employed (Murphy). After the resection one-half of a button is inserted into each segment, and is held in place by a purse-string suture of silk which passes through all the coats (Fig. 296). The redundant mucous membrane is tucked in or clipped off, so that it will not be interposed between the serous surfaces. The serous surfaces are scratched with a needle and the halves of the button are locked (Fig. 296). It is not necessary to surround the margin of junction with sutures. Murphy says that liquid nourishment should be given as soon as the patient has recovered from the effect of the ether, and that the bowels should be moved at an early period, and frequent evacuations should be maintained. If the button does not pass in four weeks, examine the rectum for it.[1] The situation of the button can

[1] John B. Murphy, in *Med. News*, Feb. 9, 1895.

be ascertained by the *x*-rays. After intestinal resection Halsted performs circular enterorrhaphy by means of his mattress-sutures.

Maunsell has devised a most ingenious method of circular enterorrhaphy. The two portions of bowel are attached by two fixation-sutures which penetrate all the coats (Fig. 298). An incision one and one-half inches in length is made through the wall of the proximal segment of gut, about one inch from its edge. The fixation-sutures are brought through this opening, traction is made upon them, the distal portion of the bowel is invaginated into the proximal portion, and the ends emerge from the opening, their peritoneal surfaces being in contact (Fig. 298). Sutures of silk are passed through both sides of the area of invagination, the threads are caught up in the center, cut, and tied on each side. The fixation-sutures are

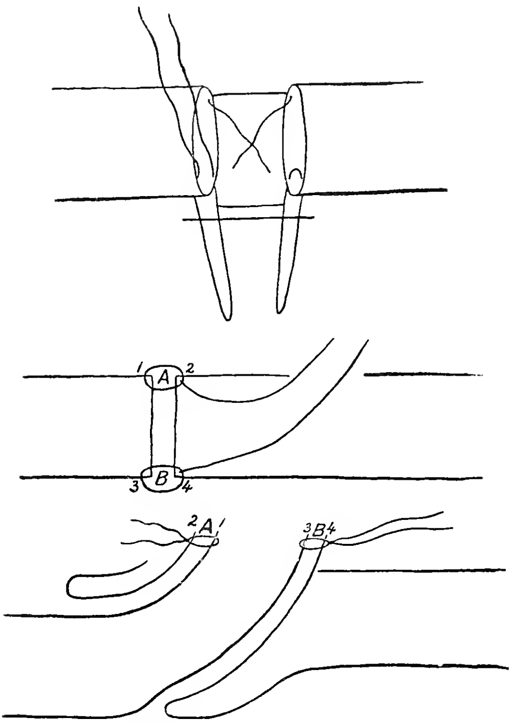


FIG. 298.—Maunsell's method of anastomosis (after Wiggin).

cut off. The invagination is reduced by traction. The longitudinal cut is closed by Lembert sutures.

Mayo Robson performs circular enterorrhaphy over a bobbin of decalcified bone (Fig. 299). Allingham uses a

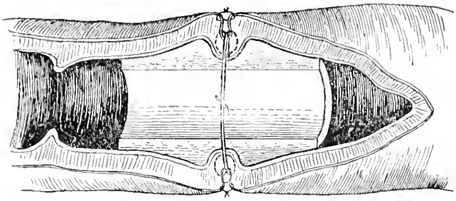


Fig. 299.—Robson's decalcified bone bobbin.

bone bobbin the shape of two cones joined at their apices. The bobbin is decalcified except an area at the center (Fig. 300). Kocher performs circular enterorrhaphy as follows: a fixation-suture is introduced through the bowel at the mesenteric attachment and another is inserted at an

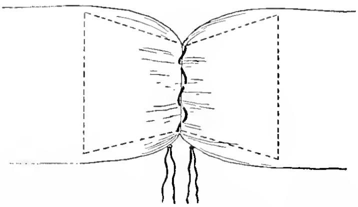


Fig. 300.—Allingham's decalcified bone bobbin.

opposite point. The intestinal ends are approximated by a continuous silk suture, which passes through all of the coats, but which includes more of the serous than of the mucous coat. The suture-line is overlaid by a continuous Lembert suture which includes the serous and a portion of the muscular coat. Harris removes a portion of mucous membrane from the distal end by means of a curet. Three needles are threaded with fine silk. The first needle is pushed through the bowel-wall to one side of the mesentery. The point of the needle picks up a portion of the distal end transversely. The needle is used as a lever to invaginate the distal end into the proximal end. The same procedure is carried out with the other needles. When invagination is effected the needles are pulled through and the threads are tied. The free end of the bowel is now sutured to the in-

vaginated part by interrupted inversion sutures or by a continuous inversion suture broken once (Fig. 301).[1]

Some surgeons employ inflatable rubber cylinders in making an end-to-end anastomosis (Halsted, Downes, and others). The method was devised by Treves, but was subsequently abandoned by him. Halsted maintains that the use of the inflatable rubber cylinder enables the surgeon to finish the operation more quickly and to dispense with clamps; arrests the vermicular motion of the intestine; makes easy the adjustment of two pieces of intestine of unequal size;

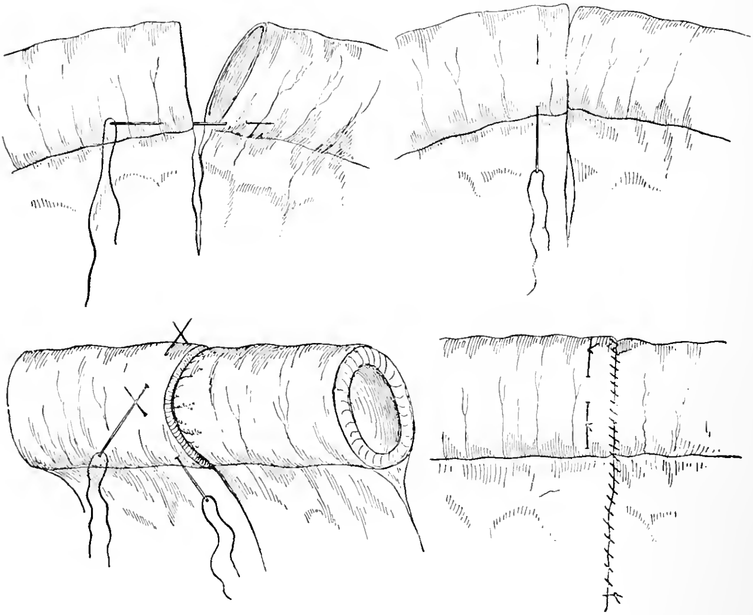


FIG. 301.—Harris's method of circular enterorrhaphy.

and renders it possible to apply stitches rapidly, evenly, and securely.[2] Three presection sutures are inserted; a portion of bowel and a V-shaped piece of mesentery are resected, the mesenteric incision being so made as to leave a vessel uncut at each edge to supply each end of the divided intestine. The mesenteric vessels are ligated and the ends of the bowel are pulled together by the presection stitches, two of which are tied. The collapsed rubber cylinder is pushed into the bowel by means of forceps and is inflated with a syringe

[1] *Chicago Med. Record*, Jan., 1897. [2] *Phila. Med. Jour.*, Jan. 8, 1898.

(Fig. 302). Twelve mattress-sutures are inserted, the bag is collapsed and withdrawn and the sutures are tied, the stitch *a* being tied first (Fig. 302). The slit in the mesentery is

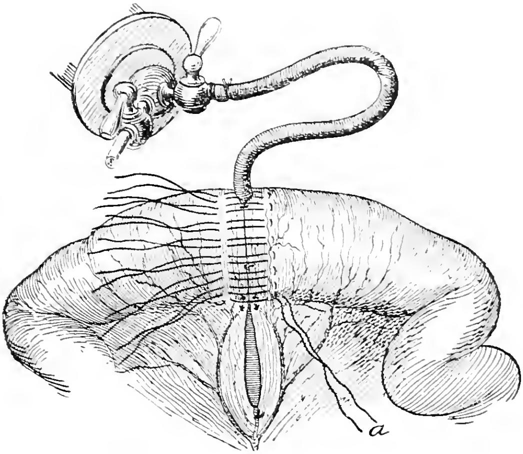


Fig. 302.—Use of Halsted's inflated rubber cylinder in circular enterorrhaphy.

sewed in such a way that the mesenteric vessels which nourish the bowel are not interfered with (Fig. 303).

Laplace has devised forceps which greatly facilitate suturing, which make it easy to obtain an even suture-line, and which can be withdrawn after the suturing is finished, the small opening through which the instrument emerged being closed with a stitch (Figs. 304, 305). By aid of Laplace's

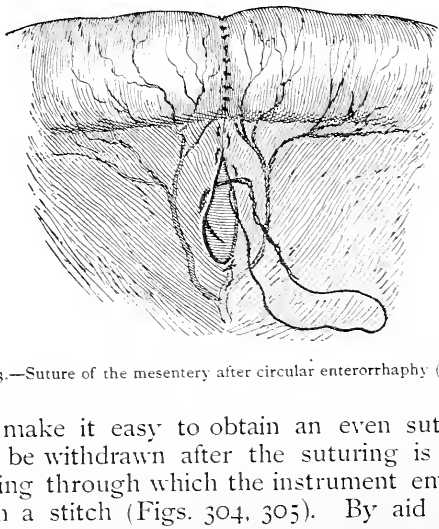


Fig. 303.—Suture of the mesentery after circular enterorrhaphy (Halsted).

forceps the operation can be neatly and rapidly performed, but a large diaphragm is formed, a considerable area is

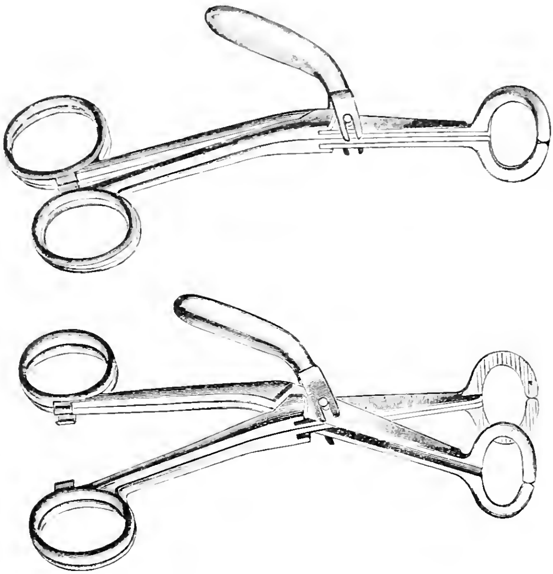


FIG. 304.—Laplace's forceps for intestinal anastomosis.

exposed to infection, the tissues of the diaphragm are bruised and may slough, and it seems probable that considerable con-

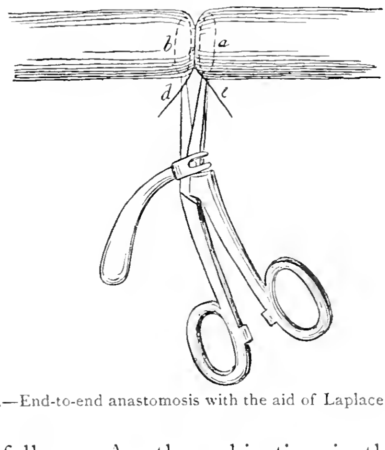


FIG. 305.—End-to-end anastomosis with the aid of Laplace's forceps.

traction will follow. Another objection is that an infected

instrument is withdrawn from the bowel and may contaminate the peritoneum.

Lateral Intestinal Anastomosis. — Approximation may be effected by other methods than by end-to-end junction or implantation. Lateral anastomosis may be practised after intestinal resection or may be done with preliminary resection for the purpose of short-circuiting the fecal current to avoid an obstruction.

Operation with Rings.—In this operation a portion of bowel above the obstruction and a loop below the obstruc-

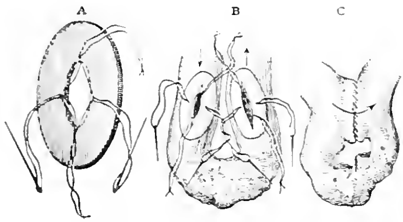


FIG. 306.—Senn's entero-anastomosis: A, Senn's bone plate; B, intestinal anastomosis; C, operation complete.

tion are brought into the wound. These segments are emptied, and are kept empty by fastening around them rubber tubes or iodoform strips. Two tubes are needed for each loop of bowel. Pack in gauze pads. Make an incision in one loop, in the long axis of the bowel, on the surface away from the mesentery; permit the contents to escape externally; irrigate this segment with saline solution; and introduce the bone plate of Senn (Fig. 306; A) or Abbe's catgut ring. Calyx-eyed needles are used, and the threads of the ring are carried through the coats of the bowel and are gathered together in the bite of a pair of forceps. The other loop of intestine is treated in a similar manner. The intestines are so brought together that the two wounds are opposite each other, the posterior sutures being tied first, the upper next, then the

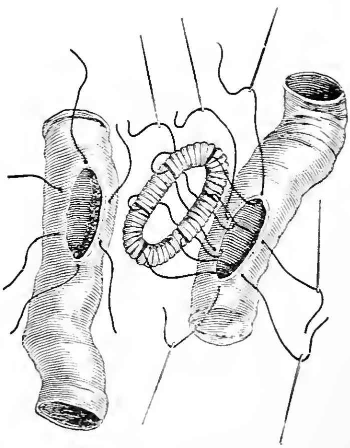


FIG. 307.—Method of passing the silk sutures in inserting the rings of Abbe.

lower, and finally the anterior threads. The ends of the threads are cut off and the entire anastomosis is surrounded by a layer of Lembert or Halsted sutures or is encircled by Cushing's suture. Fig. 306, B, shows an intestinal anastomosis partly finished, and Fig. 306, C, shows an anastomosis complete.

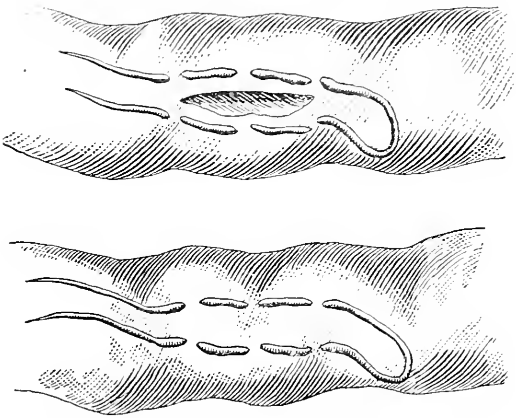


FIG. 308.—Showing relative size of incision and method of introducing sutures in lateral approximation with Murphy's button.

Fig. 307 shows the passing of the sutures when the catgut rings of Abbe are employed. After an intestinal resection, each end can be closed and anastomosis effected as described above. Lateral anastomosis can be accomplished with a

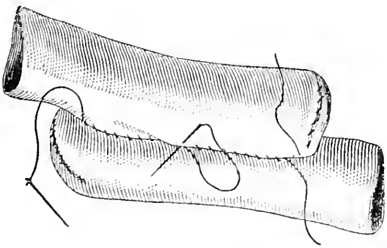


FIG. 309.—Suturing intestines in apposition before incision (Abbe).

Murphy button, the intestine being prepared for the button as is shown in Fig. 308.

Abbe's method of anastomosis without mechanical aid is as follows: after resecting the bowel and mesentery and closing the ends of the bowel he places the extremities side by side and applies two rows of a Dupuytren

suture, one-quarter of an inch apart. These rows of sutures are an inch longer than the slit in the bowel

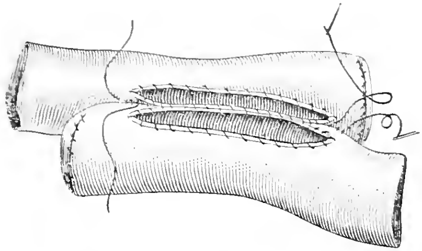


FIG. 310.—Showing the four-inch incision and sewing of the edges (Abbe).

will be (Fig. 309), the thread at the end of each row being left long. An incision is made in the bowel, one-

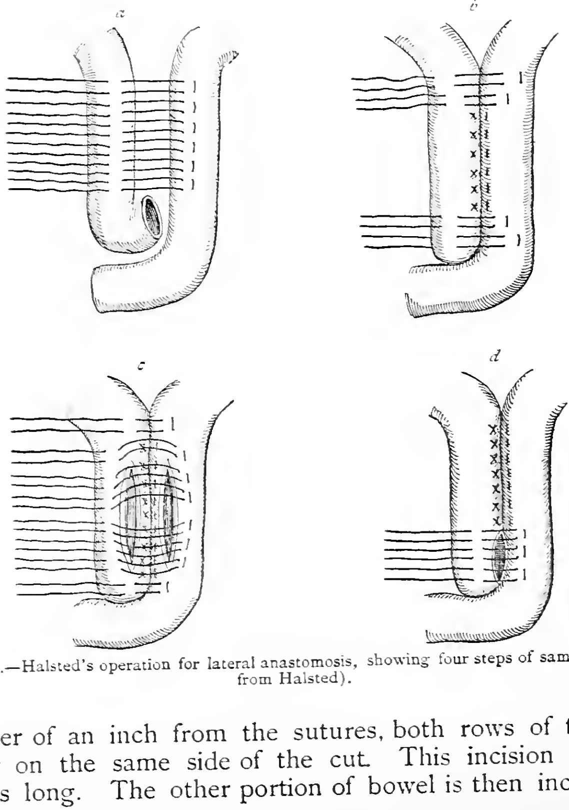


FIG. 311.—Halsted's operation for lateral anastomosis, showing four steps of same (Jessett, from Halsted).

quarter of an inch from the sutures, both rows of threads being on the same side of the cut. This incision is four inches long. The other portion of bowel is then incised in

the same way. The adjacent cut-edges are united by a whip-stitch which goes through all the coats, and the free cut-edges are stitched in the same manner (Fig. 310). The surgeon now utilizes the long threads of the first sutures, and brings the serous surfaces of the opposite sides together by means of Dupuytren's suture. Halsted performs anastomosis as follows: he places the two portions of bowel with their mesenteric borders in contact. Six quilted sutures of silk are introduced, tied, and cut off (Fig. 311, *a*). At each end of this row of sutures two quilted sutures are introduced, tied, and cut (Fig. 311, *b*). A number of quilted sutures are introduced, as is shown in Fig. 311, *c*. The intestinal openings are made with scissors, and the sutures last introduced are tied and cut off (Fig. 311, *d*).

J. Shelton Horsley has suggested an ingenious method of intestinal anastomosis which secures for the sutured portion a greater diameter than that normal to the intestine.[1] After resection of the intestine and a V-shaped piece of mesentery, the ends of the bowel are placed side by side, the openings being in the same direction, and are clamped in place (Fig. 312). The first stitch approximates the two limbs of the

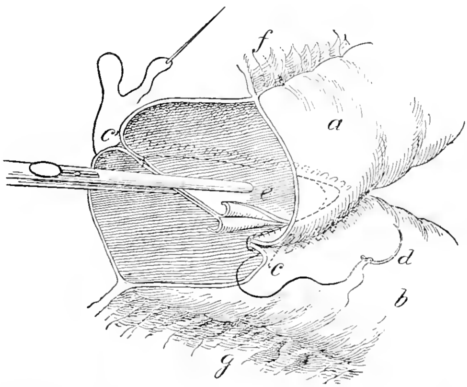


FIG. 312.—Represents the ends of the intestine in position and grasped by the artery-forceps. The first row of sutures has been partially applied, the septum partly cut away, and the second row of overhand sutures begun. *a*, *b*, are the two ends of the intestine; *c*, *c*, the first row of sutures (Cushing); *d*, the second row of sutures (overhand); *e*, the septum; *f* and *g*, the mesentery (J. Shelton Horsley).

bowel near the mesenteric attachment, is carried obliquely for about two inches to the border opposite the mesenteric attachment, and continued over the other side (Fig. 312). The septum is cut away, a margin being left one-third of an

[1] *New York Polyclinic.*

inch wide. The edge of the shelf made by cutting the septum is sutured. When the suture reaches the end of the

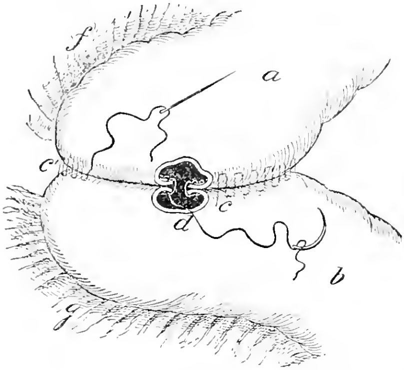


FIG. 313.—Operation nearly completed. The septum has been cut away, and the row of overhand sutures has been brought almost to its point of commencement. The cut also shows the first row of sutures (Cushing) as it should be continued after the overhand sutures are finished (J. Shelton Horsley).

shelf it is continued by invaginating the rest of the resected ends (Fig. 313).

Bodine's method of intestinal anastomosis is referred to on page 851. Laplace of Philadelphia has devised an oper-

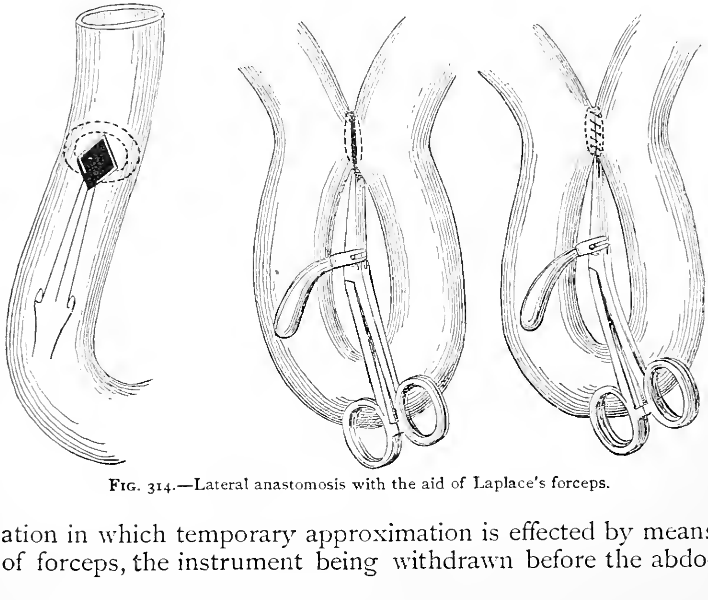


FIG. 314.—Lateral anastomosis with the aid of Laplace's forceps.

ation in which temporary approximation is effected by means of forceps, the instrument being withdrawn before the abdo-

men is closed. Junction of two segments of intestine can be quickly and neatly effected by this method and the suture line is even and secure. The objections are that an infected instrument is withdrawn from the bowel and may contaminate the surface—that a large septum is formed and tightly squeezed and this septum may slough, or may become infected conditions which will be followed by infection of the suture line, and that contraction of the collar may ensue. Figs. 314, 315 illustrate the use of Laplace's forceps in lateral anastomosis.

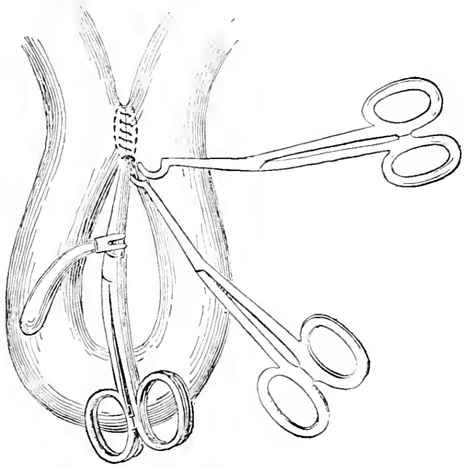


FIG. 315.—Withdrawal of Laplace's forceps.

Consideration of Methods of Intestinal Approximation.—The best method of uniting a divided intestine is a matter of dispute. The Murphy button can be applied with great rapidity, and rapid operation is of immense importance in intestinal work. The opening left by the Murphy button is small (too small some surgeons think), but it does not strongly tend in most instances to contract because the tissue-diaphragm is separated by tissue-atrophy and not by inflammatory gangrene. Occasionally the opening made by the button contracts and gives trouble; occasionally the lumen of the button blocks with feces; occasionally the button is retained, this latter complication being especially frequent after anterior gastro-enterostomy. If the button is used, liquid food should be given soon after the effect of the anesthetic has passed off, and movement of the bowels should be obtained at an early

period after operation and frequent evacuations should be maintained. The button gives better results in end-to-end approximation than in lateral anastomosis. Laplace's forceps, the decalcified bone plates of Senn, the catgut rings of Abbe, the catgut strands inside of rubber tubing of Brokaw, Chaput's button, Allingham's bone bobbin, Robson's bone bobbin, Clark's bobbin, Miller's bone buttons, buttons of leather, potato, and carrot, all have their adherents. Of mechanical appliances the best are Murphy's button, the bone ring, Laplace's forceps, and the inflatable rubber cylinder. Of recent years many surgeons have abandoned all mechanical aids, and have returned to closure without any mechanical device whatever. The ideal operation is without these contrivances. But such devices are time-savers, and to lessen the time of operation will often save life. What method to follow must be determined in each particular case by a study of the necessities of the situation. Nevertheless it may be possible to formulate a few general rules. If the condition of the patient is excellent and the bowel is in a fairly healthy condition well above and well below the seat of trouble, end-to-end approximation should be performed by simple circular enterorrhaphy. If the condition of the patient is such as to make haste necessary, use a Murphy button. If the bowel below the seat of trouble is much contracted, do not use a Murphy button, but use Senn's bone plate, or Robson's bobbin, or, better still, do simple enterorrhaphy. If the surgeon is obliged to join a very much distended bowel to a very much contracted bowel, perform end-to-side approximation (implantation) with the bone plate of Senn, by simple suturing, or else effect side-to-side junction by the method of Abbe.[1]

Operation for Intussusception.—If hydrostatic pressure or air distention fails to relieve the condition, operation should be performed. The abdomen is opened, and the surgeon endeavors by manipulation to reduce the intussusception by pushing it back, not by pulling it out. If the intussusception is gangrenous, perform intestinal resection and circular enterorrhaphy. The same rule maintains when malignant disease of the gut exists (D'Arcy Power). It is inadvisable to make an artificial anus. Maunsell's operation is suited to cases of irreducible intussusception. It is performed as follows: a longitudinal incision is made in the intussuscipiens. The intussusception is gently

[1] See the discussion of this subject by the late Greig Smith in his *Abdominal Surgery*.

pulled upon and is caused to protrude from this opening. Two straight needles threaded with horse-hair are passed so as to transfix the base, and one-fourth of an inch above the needles the intussusception is cut off. The needles are carried completely through, the sutures are hooked up in the middle and cut, and the two ends are tied on each side. These sutures unite the intussusception to the intussuscipiens. The two surfaces are now carefully approximated by sutures. The sutures are cut. The stump is replaced. The longitudinal incision is closed with Lembert sutures.[1]

Senn's Operation for Fecal Fistula.—Suture the opening transversely with Czerny sutures of silk in order to prevent infection. Cleanse the surface thoroughly. Open the abdomen and separate the edges of the bowel from the parietes. Deliver the portion of bowel which contains the fistula and apply Lembert sutures over the Czerny sutures. Another method is to open the abdomen above the fistula, insert the fingers, cut out the skin and tissues around the fistula in an elliptical course, leaving them attached to the bowel, draw the bowel from the abdomen, pack gauze around, remove the tissues adherent to it, and suture the fistula transversely (Hearn).

Enterostomy is the making of an artificial anus. If performed in the large bowel, it is called colostomy. In some cases of intestinal obstruction it is necessary to open the small intestine, and if this is required the artificial anus should be made as near as possible to the cecum. The nearer the stomach it is made the more apt is the patient to die of lack of nourishment. The anus may be made in the middle line or in the right iliac region. The bowel is fixed and opened as directed under colostomy. In acute intestinal obstruction it may be necessary to open the bowel at once. In such a case Paul's tube is very useful. Paul's tube is made of glass, is bent to a right angle, and has a rim near each end. The large tube is used in the colon, the small tube in the small intestine. A small opening is made in the intestine, the tube is introduced, and is tied in place by a silk suture which surrounds all of the coats of the bowel, a quantity of feces is caught in a basin, a rubber tube is fastened to the glass tube, and fluid feces are collected in a bottle under antiseptic fluid.[2] In from three or four days to a week the tube becomes loose and can be removed.

Inguinal Colostomy.—Maydl's Operation.—In this

[1] T. Pickering Pick, *Quarterly Med. Jour.*, Jan., 1897.
[2] Paul, in Liverpool *Med.-Chir. Jour.*, July, 1892.

operation a vertical or oblique incision four inches long is made over the portion of colon to be incised. In all cases where it is possible, do a left inguinal colostomy. The colon usually bulges into the wound, but if it does not it may easily be found by following with the finger the parietal peritoneum outward, backward, and inward, the first obstruction it encounters being the mesocolon. Draw the colon out of the wound until its mesenteric attachment is level with the abdominal incision. Push a glass bar through a slit in the mesocolon near the bowel, and wrap the ends of the bar with iodoform gauze to prevent slipping. Instead of the bar, a piece of gauze can be employed, or a bridge of skin can be made under the bowel by suturing the two skin edges. The two parts of the flexure are stitched together by sutures which penetrate to and catch the submucous coat (Fig. 316). If it is

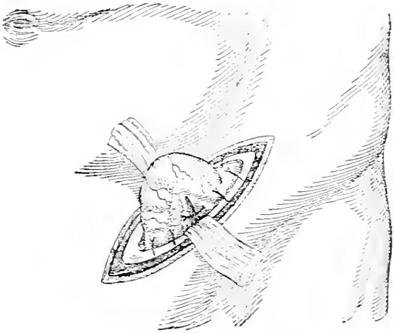


FIG. 316.—Inguinal colostomy (after Zuckerkandl).

necessary to open the colon during the operation, stitch the serous coat of the bowel to the parietal peritoneum before opening. Whenever possible, wait from twelve to twenty-four hours before opening. The colon is opened by the cautery or by scissors. If the artificial anus is to be permanent, make a transverse incision through the bowel. Some surgeons cut one-fourth way through the colon when it is first opened, and entirely across at a later period. If the artificial anus is to be temporary, the incision is longitudinal. This operation has great advantages: it is quick, certain, reasonably safe, and satisfactorily prevents fecal accumulation below the opening.

Bodine's Operation.—Bodine's method of colostomy permits of a future restoration of the fecal current by an easily performed anastomosis. This surgeon maintains that the spur

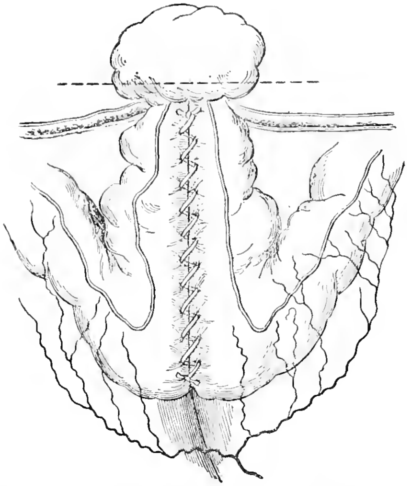


Fig. 317.—Bodine's method of colostomy, showing one side of the loop after it has been sutured, passed back into the cavity and stitched into the abdominal wound. The lesion is left protruding, and the dotted line indicates where the protrusion is to be clipped off.

after colostomy should reach to and remain at the level of the skin, a condition impossible of attainment by hanging the bowel over a rod or piece of gauze, because a spur thus

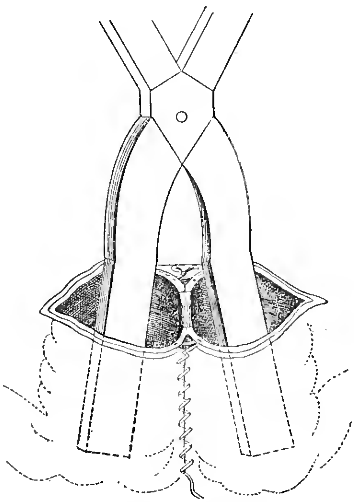


Fig. 318.—Bodine's method of colostomy, showing the septum to be divided in restoring the fecal current; Grant's clamp in position for the division. (In permanent colostomy this septum remains as a rigid and effective spur).

formed is not thick and rigid and is inevitably dragged below the skin-level, and when this dragging has taken place some fecal matter will pass into the bowel below the artificial anus. Bodine opens the abdomen, sutures the parietal peritoneum to the skin, seeks for the lesion, and draws it with six inches of healthy bowel out of the incision. He lays the limbs of the loop side by side. He inserts a silk stitch, beginning at the point where exsection is to be made, and for six inches unites the two segments close to their mesenteric borders. The loop is dropped into the abdomen until the beginning of the suture is on a level with the skin, and at this point it is fastened to the abdominal wound with a continuous catgut suture. The protruding lesion is cut off along the dotted line (Fig. 317). The artificial anus is thus established. When it is desired to close the artificial anus, divide the septum with scissors or a Grant clamp, and close the abdominal wound (Fig. 318).[1]

Lumbar colostomy is a most unsatisfactory operation, which does not completely intercept the fecal current, and which leaves the patient in a condition of wretched discomfort. It is rarely performed at the present day.

Cholecystotomy is the operation of opening the gall-bladder in order to remove gall-stones or secure drainage. It is performed in cases of acute cholecystitis; in hydrops of the gall-bladder; in cases of gall-stone in which jaundice has lasted for four weeks or more, and in colic of the gall-bladder with fever, the colic having recurred a second or third time (Carl Beck). The operation completed in one stage is performed as follows: The patient is placed recumbent with a sand-pillow under the back. A vertical incision is made in the right linea semilunaris. The peritoneum is opened. If the gall-bladder is distended, it is surrounded with pads and aspirated, and is then opened. Gall-stones are removed by forceps, the scoop, or irrigation. The gall-ducts are examined by the fingers external to them, and are sounded if possible. If a stone is wedged in the duct, try to manipulate it back into the gall-bladder. If this fails, introduce an instrument from the gall-bladder and break up the stone; if this fails, open the duct, remove the stone, and close the incision in the duct (Mayo Robson). Pass a rubber tube which has no side perforations into the gall-bladder, cut it off level with the cutaneous surface, and suture the gall-bladder to the abdominal aponeurosis. The drainage-tube can usually be dispensed with in from a week to ten days.

[1] *New York Polyclinic*, Feb. 15, 1897.

Some surgeons have advocated immediate suture of the gall-bladder after removing a stone. This is not advisable, because small calculi may be in the ducts, and minute fragments of stone are often left in the bladder, and the drainage will remove them and relieve the diseased condition of the gall-ducts and bladder. Further, the operation with immediate suture is decidedly more dangerous.

It is advised by some that the operation of cholecystotomy be performed in two stages. First, the bladder is exposed and sutured to the parietal peritoneum. When adhesion takes place the gall-bladder can be opened without risk of infecting the general peritoneal surface. Riedel advocates operation in two stages, and so does Christian Fenger in certain cases. The fistula which is left by cholecystotomy usually closes spontaneously, but may not. If it does not close and the secretion is pure mucus, it is evident that the cystic duct is absolutely blocked and cholecystectomy should be performed.

If the secretion is bile and the common duct is not obstructed, separate the edges of the gall-bladder opening from the parietal peritoneum, endeavoring to avoid entering the abdominal cavity, and close the fistula with Lembert or Halsted sutures. If the secretion is bile and the common duct is obstructed permanently, perform cholecystenterostomy.

Cholecystenterostomy consists in making an anastomosis between the gall-bladder and intestine, preferably the duodenum. It is employed in cases of irremovable obstruction of the cystic or common duct. It can be done most rapidly and successfully by means of a small Murphy button. Before the gall-bladder is incised it is aspirated. The operation is shown in Fig. 319, and is similar in performance to intestinal anastomosis.

Cholecystectomy is the extirpation of the gall-bladder. Its performance may be demanded by the existence of phlegmonous inflammation or gangrene, ulceration, "in chronic cholecystitis from gall-stones where the gall-bladder is shrunken, and too small to safely drain, and where the common duct is free from obstruction" (A. W. Mayo Robson), in empyema with greatly damaged walls, in fistula associated with irremediable obstruction of the cystic duct, the common duct being free, and in some wounds.

The peritoneum which covers the gall-bladder must be divided just below the liver, the gall-bladder is dissected from the liver until the cystic duct is reached, the duct is ligated with silk and divided, the stump is touched with pure

carbolic acid and is covered with a layer of peritoneum fastened by sutures of fine silk.

Choledochotomy is the operation of incising the common duct for the removal of a stone. It is also called choledocho-lithotomy. A sand-bag should be placed under the back. The abdominal incision must be longer than that employed for cholecystotomy. The pylorus and stomach are drawn to the left, the colon and omentum are drawn downward, and the liver and ribs are lifted strongly upward.

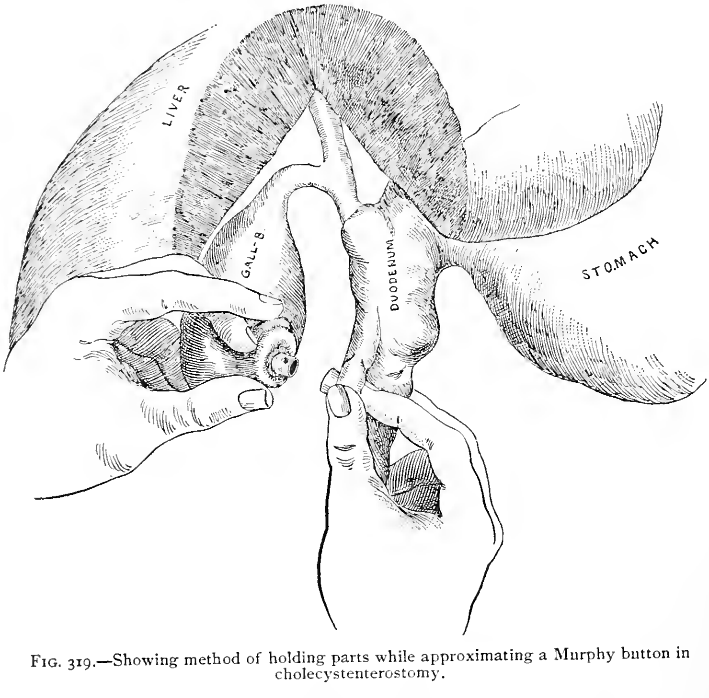


FIG. 319.—Showing method of holding parts while approximating a Murphy button in cholecystenterostomy.

"The operator should now, after having separated adhesions, have a good view of the common duct within the free border of the lesser omentum, and on inserting his left index-finger into the foramen of Winslow, or on grasping the duct between the index-finger and thumb, he can, without difficulty, bring the duct well within reach, the concretion making a distinct projection."[1] A longitudinal incision is made,

[1] A. W. Mayo Robson's *Treatise on Diseases of the Gall-bladder and Bile-ducts.*

the stone is removed, and a probe is introduced into the duct to determine whether other stones are present.

If possible, suture the incision in the duct. This procedure is rendered easier by the use of Halsted's hammer which draws the duct toward the surface and keeps it under control (Fig. 320).

Interrupted sutures of fine silk are used. The muscular and serous coats may be included in each suture, and over this layer Lembert or Halsted sutures are applied. A drainage-tube is inserted and a piece of iodoform gauze is placed upon the suture line, the other end being brought out of the

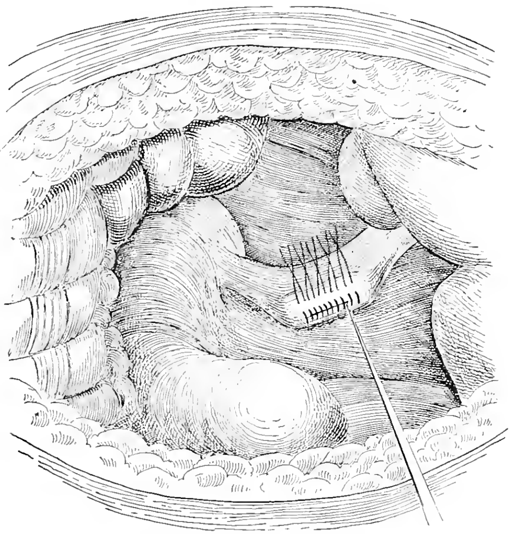


FIG. 320.—Suture of duct over hammer.

abdominal wound. This precaution is taken because leakage may occur. If it is found impossible to suture the wound in the duct, carry a glass tube down to the opening and surround it with iodoform gauze, or make an incision into the loin after the plan of Rutherford Morrison, and carry a tube into the right kidney pouch, which is the most dependent part of the peritoneal cavity when the patient is recumbent.

Splenectomy.—This operation is performed for wounds and rupture of the spleen, cysts, floating spleen, and non-leukemic splenic hypertrophy. It should not be performed if leukemia exists. The incision is from the anterior superior spine of the ilium to the ribs (Bryant). The peritoneum

is opened. Adhesions are divided between ligatures. If the spleen is adherent to the pancreas, it may be necessary to remove a fragment of the last-named organ (Esmarch). Ligate the suspensory ligament and cut it. Bring the spleen well out of the wound. Surround it with gauze pads. Transfix the pedicle with stout silk. Tie it firmly, leaving the ends of the ligature long for a time, and cut through the pedicle beyond the ligature. Ligate the vessels separately with catgut. Cut off the long ends of the silk ligature and drop the pedicle back, unless apprehensive of bleeding, when it may be fastened to the surface. The wound is closed without drainage.

About two weeks after the removal of a normal spleen certain definite changes happen in adults but not in children. These changes last for several weeks and are manifested by enlargement of the lymph-glands, tenderness of bones, and blood-changes, loss of weight, weakness, thirst, polyuria, abdominal pain, elevation of temperature, and rapid pulse.[1] Tizzoni says that these changes are not obvious in children, because in them compensatory organs act at once, whereas in adults compensatory organs act slowly and with painful effort. Such symptoms are noticed when the spleen is removed because of a wound or a rupture, and rarely after removal of a diseased spleen. It is likely that compensating organs become active when the spleen is diseased, and consequently are in full operation when such a spleen is removed. After partial splenectomy these conditions do not arise (Jordan). Changes can be prevented after splenectomy by the administration of tablets of extract of spleen and red bone-marrow (Ballance).

Abdominal Hernia or Rupture.—This condition is the protrusion of a viscus or part of a viscus from the abdominal cavity. MacCormac says the term implies that the protruded viscus is covered with integument; hence a protrusion of viscera through a wound does not constitute a hernia. A hernia has three parts—the sac, the sac-contents, and the sac-coverings. The *sac* is formed of peritoneum. A congenital sac is due to developmental defect, and is found only in the inguinal or umbilical region. An acquired sac is due to intra-abdominal pressure bulging the peritoneal covering of the internal abdominal ring and converting it into a pouch. The sac comprises a body, a neck, and a mouth. A sac once formed is almost certain to persist, because it adheres by its outer surface to surrounding parts,

[1] Ballance, in *Practitioner*, April, 1898; H. Martyn Jordan, in *Lancet*, Jan. 22, 1898.

and hence the sac of a hernia is usually irreducible even when the contents are reducible. The neck of the sac is due to the constriction through which the sac passes; it becomes furrowed and folded, and the adhesion of these folds causes thickening and rigidity. Hernia of the bladder or of the cecum has no sac, or but a partial sac. The *contents of the sac* depend chiefly on the situation, a portion of the ileum being the usual contents. The colon, the stomach, the great omentum, the bladder, and other structures may enter the hernial sac. An *enterocele* contains only intestine; an *epiplocele* contains only omentum; an *entero-epiplocele* contains both omentum and intestine; a *cystocele* contains a portion of the bladder. The *coverings of the sac*, which vary with its situation, will be set forth during the consideration of special forms of hernia. In old herniæ the layers are never distinct, fat and muscle waste, tissues adhere, and the skin stretches and atrophies. The sac of a hernia occasionally becomes tubercular. This condition arises in old herniæ. It may either remain local in the hernial sac or spread to the general peritoneum. Renault tells us that tuberculosis of a hernia is made manifest by increase in size, pain on pressure, and loss of body-weight.

Causes of Hernia.—The male sex is most liable to hernia. It occurs at all periods of life, and hereditary predisposition sometimes seems to exist. Excessive length of the mesentery has been assigned as a cause. In some instances a mass of fat forms and appears before the hernia, and seems to bear a causative relation to it. Lucas-Championnière explains this as follows: when a person begins to take on fat, it is deposited not only under the skin, but also in the omentum, mesentery, and subperitoneal tissues. This semifluid fat is easily influenced by pressure. The deposit of fat within the abdomen lessens the size of that cavity, intra-abdominal pressure is increased, and fat protrudes at any weak spot in the wall. The protruding mass of fat adheres to and makes traction upon the peritoneum, and this membrane is drawn upon to form a sac, and the sac is surrounded by fat. This method of formation is frequently noticed in umbilical herniæ, and occasionally in inguinal herniæ. Any laborious occupation predisposes to rupture. Any condition which weakens the abdominal wall predisposes (muscular relaxation from ill-health, relaxation of abdominal walls following the termination of pregnancy, the removal of a large tumor, or tapping for ascites, and wounds or abscesses of the abdominal wall). The exciting cause is muscular effort (strain-

ing at stool, coughing, lifting weights, jumping, the sexual act, and straining to make water). All congenital herniæ are due to structural defects. Herniæ are divided clinically into *reducible, irreducible, incarcerated, inflamed,* and *strangulated.*

Reducible Hernia.—In this form of hernia the contents of the sac can be reduced into the abdominal cavity. At a known hernial opening the patient has a smooth enlargement (narrower above than below), which began to grow above and extended downward. A distinct neck can often be felt. In enterocele, straining, lifting, or standing enlarges the mass; the protrusion becomes smaller and may disappear on lying down; cough causes impulse or succussion; the protrusion is elastic, and on reduction the mass suddenly disappears and there is a gurgling sound. In epiplocele the mass is often irregular and compressible, and feels boggy rather than elastic; muscular effort does not have much influence in enlarging it; impulse on coughing is slight; percussion gives a dull note, and reduction is accomplished gradually and produces no gurgling sound. In entero-epiplocele some parts of the mass are smooth, elastic, and tympanitic, others are dull on percussion, irregular, and flabby; but the diagnosis of this especial form is uncertain. The victims of reducible hernia complain of some pain on exertion, of dyspepsia, and often of constipation.

When a hernia is beginning to form a patient complains of muscular pain in the lower abdomen, and this condition may exist for weeks before it is recognized that a hernia is present. An inguinal hernia should be recognized before it protrudes from the external ring. The tip of the finger is inserted in the ring and the patient is asked to cough. If a hernia has entered the canal, succussion will be detected on coughing. In a healthy man the external ring should admit the tip of the little finger, but not the end of the index-finger. If the end of the index-finger can be made to enter the ring, that aperture is dilated; and even if there is no hernia in the canal, in future a hernia will probably descend. In a man, if the surgeon desires to examine the ring, he inverts the skin of the scrotum over the finger and carries the finger to or in the ring.

Treatment of Reducible Hernia.—Palliative Treatment.—Prevent constipation, forbid sudden strains and violent exercise, and order a truss. The continued employment of a truss, especially in young persons, may bring about a cure.

The day truss should be applied before rising in the morning and be removed after lying down at night, when a light truss should be substituted. A special truss is applied before bathing. In very fat people there is always trouble in adjusting a truss. A femoral hernia is more difficult to keep reduced than an inguinal hernia. In a hernia in which the gut is replaceable, but a portion of omentum is irreducible, it is difficult to maintain reduction of the gut with a truss, and an operation should be performed. In an oblique inguinal hernia the pad of the truss fits over the internal abdominal ring; in a direct inguinal hernia, over the external abdominal ring; in a femoral hernia, over the femoral ring at the level of Gimbernat's ligament. MacCormac's method of measuring for a truss is as follows: in either inguinal or femoral hernia start the tape from the *lower part* of the hernial opening, carry it up to the anterior superior iliac spine of the same side, then take it around the body, one inch below the crest of the ilium, to the other anterior superior iliac spine, and then to the upper part of the hernial opening.[1] A well-fitting truss will keep the hernia up even when the patient sits in a position to relax the abdominal walls and coughs and strains. A truss is always uncomfortable at first, but a person usually becomes accustomed to it. It should be kept scrupulously clean, and it is well to dust borated talc powder upon the skin under the pad at least once a day. A truss which does not keep the hernia up or which causes pain does harm. Too strong a spring tends to enlarge the hernial orifice, and thus aggravates the case. Even after an apparent cure with a truss the instrument must be worn for a long time.

Radical treatment seeks to permanently cure by plugging the mouth of the sac or by obliterating the canal of descent. Radical operations should be performed when a strangulated hernia is operated upon, in ordinary cases of reducible hernia in which a truss is very painful or does not keep the bowel up, in most cases of irreducible hernia, and in any case which has occasional attacks of obstruction. It used to be believed that a cure would fail if the subject was under three years of age, but Coley and others have proved that it is a very successful operation in children. In any operation for the radical cure of hernia always remember that the bladder may be part of the hernia, and be on the lookout for it. As a rule, it is covered with cellular fat, which differs in color and consistence from omental fat and from other fat which

[1] Treves's *Manual of Surgery*, "Hernia."

may be found about a hernia. It was the author's misfortune to open a bladder in operating upon an inguinal hernia.

Lannelongue's Method.—Lannelongue has for certain cases returned to the old injection plan, using a 10 per cent. solution of chlorid of zinc instead of white oak bark. The hernia is first reduced and is held up by an assistant who closes the internal ring with a finger, and also holds the cord aside. Several injections of 10 minims each are thrown in the region of the internal pillar, the region of the external pillar, and into the canal behind and outside of the cord. The surgeon must be careful that no zinc solution escapes into the subcutaneous tissue. The effect of the chlorid of zinc is to cause the formation of quantities of fibrous tissue. It is scarcely to be expected that a cure so produced will be permanent in an adult, though it may be in a child.

Macewen's Operation for Inguinal Hernia.—The instruments required in this operation are scalpels, a blunt, straight bistoury, a dry dissector, a grooved director, scissors, a hernia-director, hernia-needles (Fig. 321), dissecting-forceps, toothed forceps, hemostatic forceps, an aneurysm-needle, blunt hooks, half-curved needles, needle-holder, and chromicized catgut sutures. The patient lies recumbent, the thigh being abducted and partly flexed and resting on a pillow beneath the knee. The bowel is reduced, and an incision three inches long is made in the direction of the inguinal canal, the center of the incision corresponding to the external ring. The sac is freed from its attachments below and is lifted up. The surgeon introduces a finger into the inguinal canal and separates the sac from the cord and from the walls of the canal, and then carries the finger through the internal ring and separates the peritoneum for one inch about the periphery of this aperture (Fig. 322, A). A chromicized catgut stitch is fastened to the lowest portion of the sac, and is passed through the sac several times, so that pulling on the stitch will purse the sac (Fig. 322, B). The free end of this stitch is carried through the internal ring into the belly, and is pushed out through the abdominal muscles one inch above the internal ring, the skin being pushed aside so as to escape perforation by the needle. The thread is tightened so as to fold up the sac and pull it into the belly. This plugs the ring (Fig. 322, C). The thread is handed to an assistant

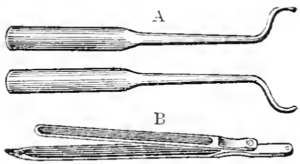


FIG. 321.—A, hernia-needles; B, hinged hernia-director.

to keep tight until the sutures are introduced into the ring, when the sac is permanently anchored by taking several

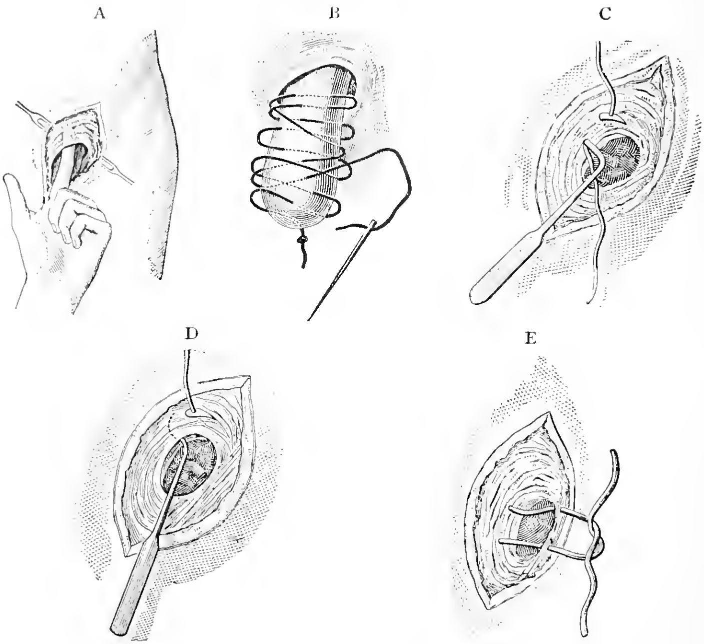


FIG. 322.—Macewen's operation for radical cure of inguinal hernia; A, stripping of the sac; B, purse-string suture; C, fastening the purse-string suture; D, passing, and E, tying, the sutures for the internal ring.

stitches in the external oblique muscle. A strong catgut suture is passed with a Macewen needle through the conjoined tendon from below upward, the ends of this suture being carried through Poupart's ligament and the outer border of the internal ring from within outward. This suture is tightened and closes the internal ring. The external ring is sutured and the skin is stitched together (Fig. 322, E).

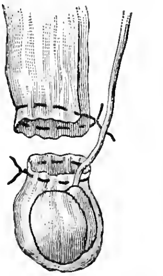


FIG. 323.—Macewen's operation for the radical cure of congenital hernia.

In congenital hernia the sac is divided in its middle, and the lower part is closed by stitches of chromic catgut, forming a tunica vaginalis. The upper part of the sac is slit posteriorly to permit the escape of the cord, and is closed by stitches of chromic catgut. The operation is finished as in the acquired form (Fig. 323). After

this operation the patient should stay in bed for about four weeks, and must not work for eight or nine weeks. Workmen after this operation should always wear a pad and a spica bandage. Children require no pad. Never apply a truss, as strong pressure will produce atrophy of the curative scar.

Bassini's and Halsted's Operations for Inguinal Hernia.—Bassini's operation displaces the spermatic cord from the old canal and places it in a new canal, and this new canal is oblique. The instruments employed are the same as for Macewen's operation, excepting the special needles, which are not needed. Hagedorn needles are employed to insert the stitches. The suture-material is kangaroo-tendon or chromicized catgut. Silk or silver wire is apt to make trouble—it may be long after the operation. The position is the same as in Macewen's operation. An incision is made from the external ring to a point external to the internal ring. The sac is exposed and twisted, its neck is ligated, and it is cut off in front of the ligature. The spermatic cord is lifted (Fig. 324, A); the border of the rectus muscle, the edges of the internal oblique and the transversalis muscles, and the transversalis fascia, are sutured to the lower shelf of Poupart's ligament below the cord (Fig. 324, B). The border of the external oblique is sutured to the upper shelf of Poupart's ligament above the cord (Fig. 324, C). The skin is sutured by interrupted stitches of silkworm-gut or the edges of the wound are approximated by a subcuticular stitch of catgut or silver wire. In this operation the author is accustomed to treat the sac as in Macewen's operation, carrying out the rest of the procedure as directed above. In a pure Bassini operation the funnel-shaped depression in the peritoneum at the point of emergence of the cord remains and predisposes to hernia, but the use of Macewen's plan for treating the sac obviates this. Halsted's operation consists in incising the external oblique, incising the lower edge of the internal oblique, opening the sac above the level of the

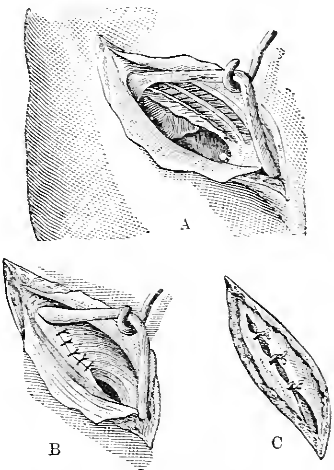


FIG. 324. A–C.—Bassini's operation for the cure of inguinal hernia.

internal ring, cutting the sac across, suturing the wound in the peritoneum as a laparotomy wound is sutured, grasping the free end of the sac and separating the sac from the cord, resecting some of the large veins to lessen the diameter of the cord, placing the cord between the external oblique muscle and the integument, and suturing the muscular structures beneath the cord with mattress-sutures of silver wire, and closing the skin incision with a subcuticular suture. Halsted's subcuticular suture is almost identical with the subcuticular suture of Kendal Franks of Dublin. Chassiagnac, as long ago as 1851, recommended a subcutaneous suture. Halsted's suture is not subcutaneous, but subcuticular or intradermal. The material employed may be silver wire, catgut, or silk. It is inserted by means of a medium-sized Hagedorn needle held in a needle-holder. It is carried through the derma at the one margin of the wound and then of the other, and so on. When it is inserted the ends of the suture are pulled and the wound is approximated. In introducing this suture the needle does not pass through the epiderm, and hence there is no danger of infecting the wound with the staphylococcus epidermidis albus. Halsted's operation makes a new internal ring through the internal oblique and external oblique muscles, and makes a new inguinal canal. Halsted and Bloodgood have noticed that removal of the cord from its bed may be followed by epididymitis, or even atrophy of the testicle; hence in many cases they leave the cord in its bed, and transplant or resect the veins.

Kocher's Operation.—Kocher exposes the aponeurosis of the external oblique, makes a small incision through the aponeurosis above and external to the internal ring, and draws the sac through this incision and sutures it in place.

Fowler's operation is as follows: an incision is made parallel with Poupart's ligament from the spine of the pubis to the level of the internal ring, and a flap is turned up. The inguinal canal is opened and the sac and cord isolated. The sac is opened, its contents reduced, it is cut off, and its edges grasped with forceps. The deep epigastric artery and vein are sought for, each is tied in two places and divided between the ligatures. The index-finger is introduced into the belly, and on this as a guide the floor of the canal is divided (transversalis fascia, subserous tissue, and peritoneum). The cord is placed in the peritoneal cavity. The edges of the opening are sutured so that broad serous surfaces are approximated, through-and-through sutures being passed

from side to side. The cord is brought out at the inner end of the incision, the lower angle of the cut being at such a level that the cord curves upward and forward as it leaves the abdomen. The inguinal canal, the gap in the aponeurosis, and the skin-wound are closed.[1]

After a radical cure by any method the patient should remain in bed four weeks.

Radical Cure of Umbilical Hernia.—Make an elliptical incision through the skin around the mass. Endeavor to separate the sac from the superficial tissues. If this cannot be done, open the sac and separate it from the contents. Even if the sac can be stripped from the skin, always open it and separate the contents. Return any bowel which may be present, and do not forget that there may be a small portion of bowel completely encased in omentum. Tie into segments and cut off the superfluous omentum and return the stump into the belly. Excise the umbilicus (omphalectomy). Suture the peritoneum with a continuous catgut suture. Close the musculofascial wall with two layers of interrupted kangaroo-tendon sutures or one layer of silver wire mattress-sutures. Close the skin by interrupted sutures of silkworm-gut or a subcuticular stitch.

Radical Cure of Femoral Hernia.—Cheyne ligates the neck of the sac, stitches the stump to the abdominal wall, dissects out a flap from the pectineus muscle, stitches this flap to Poupart's ligament and to the abdominal wall, and thus fills up the crural canal. Bassini makes an incision parallel with Poupart's ligament, ties the neck of the sac, cuts below the ligature, and returns the stump into the belly. He attaches by deep sutures Poupart's ligament to the pectineal aponeurosis as high up as the pectineal eminence, the cord or round ligament being drawn out of the way. Superficial sutures are passed between the pubic portion and the iliac portion of the fascia lata.

The operation of Fabricius is as follows: an incision is begun over the pubic spine and is carried outward for five inches parallel with Poupart's ligament. The sac is exposed, isolated, and opened, and its contents are reduced, its neck is ligated, the sac is cut off, and the stump is dropped back. An incision is now made below Poupart's ligament so as to separate this structure and the fascia lata, and the flap of fascia is turned down. The crural sheath and the vessels are retracted, and the origin of the pectineus muscle is sutured to Poupart's ligament. The flap of fascia lata is sutured

[1] *Annals of Surgery*, Nov., 1897.

to the aponeurosis of the external oblique, and the skin is sutured.

Irreducible Hernia.—The swelling in irreducible rupture presents the usual evidences of hernia, shows an impulse on coughing, but cannot be replaced in the abdomen. Sometimes a portion is reducible and a portion is irreducible. A hernia may become irreducible because of the size of the mass, because of adhesions, or because of great growth of omental fat. An irreducible hernia is liable to be bruised and to cause much distress and pain, and is always a menace to life because of the danger of obstruction and strangulation. It was formerly the custom to support a small irreducible hernia by a hollow padded truss; a large hernia of this variety may be carried in a bag-truss. The patient must not take very active exercise, must keep the bowels regular, and must live upon a plain diet. Most cases of irreducible hernia should be treated by operation.

Incarcerated or Obstructed Hernia.—Obstruction takes place by the damming of feces or of undigested food, the fecal current being arrested, but the blood-current in the wall of the bowel being undisturbed. Incarceration is commonest in irreducible hernia, umbilical hernia, and during the existence of constipation. The tumor enlarges and becomes tender, painful, and dull on percussion; pressure diminishes it in size; it is irreducible, but still presents impulse on coughing. The abdomen is somewhat distended and painful; there are nausea, constipation, and not unusually slight vomiting. Constitutional disturbance is slight and constipation is not absolute, gas at least usually passing. Vomiting is not fecal. The *treatment* is rest in bed in a position to relax the belly, an ice-bag over the hernia, and a little opium for pain. Do not give a particle of food for twenty-four hours; when the active symptoms subside give an enema, and after this acts a dose of castor oil. Do not employ taxis, as bruising the bowel may produce strangulation.

Inflamed Hernia.—Inflammation of a hernia is local peritonitis due to injury of an irreducible hernia. The mass becomes tender, painful, and hot. In enterocele much fluid forms; in epiplocele the mass becomes hard. The hernia cannot be reduced; there is constipation, often vomiting, usually fever, but the mass still shows impulse on coughing. Vomiting is not fecal. Some gas is usually passed through the bowels. Constitutional symptoms are slight. The *treatment* usually recommended is rest in bed with abdominal relaxa-

tion, an ice-bag to the tumor, a small amount of opium by the mouth if pain is severe, an enema, and when this acts a saline. In an inflamed hernia there is great danger of strangulation, and operation should be performed in preference to relying upon the conservative plan.

Strangulated hernia is a condition in which, if the hernia contains bowel, not only is the fecal circulation arrested, but the circulation of blood in the bowel-wall is also arrested. The bowel is irreducible and obstructed, and the blood ceases to circulate. If the hernia contains omentum, the omental vessels are tightly constricted. Strangulation is commonest in old inguinal ruptures in active, middle-aged men, and is more frequent in enteroceles than in epiploceles. It may be due to entry into the sac of more intestine or omentum, which has been forced down by sudden movement or violent effort. It may be due to active peristalsis or to congestion, and it may arise from inflammation or from incarceration. The constriction is usually at the neck of the sac, in the outside tissues, or even in the sac itself. In an hour-glass hernia the constriction is in the body of the sac. Adhesions within the sac may cause strangulation. Spasmodic contraction of the tissues about the neck of the sac is an exploded hypothesis. When strangulation once begins the hernia swells, a furrow forms on the bowel at the seat of constriction, the bowel and omentum below the constriction become deeply congested and edematous, and, finally, the hernia passes into a state of moist gangrene. The gangrene may be in spots or the entire mass may be gangrenous. The sac is apt to inflame, and inflammation produces fluid and lymph; serum accumulates in the sac, being first clear, then bloody, and finally brown and foul. When gangrene is once established the bowel is in danger of rupturing. At the point of contraction there may be a line of ulceration. A strangulated femoral hernia becomes gangrenous more rapidly than does a strangulated inguinal hernia.

Symptoms.—An individual who has a hernia is seized with pain in and about the hernia and with violent colicky pain about the umbilicus, and the paroxysms of colic become more and more frequent, until finally the pain may become continuous. The hernia is found to be irreducible; larger than usual, tender, painful, dull on percussion, without impulse on coughing, and the skin above it may be reddened. Eructations of gas are frequent and generally uncontrollable vomiting and prostration come on. Vomiting, as a rule, is an early symptom, and one which increases in severity.

Occasionally it only follows the swallowing of liquids. Not unusually there is retching rather than vomiting. In rare cases it does not arise for twenty-four to forty-eight hours. During the course of a strangulation vomiting may cease for a day or more, and it not unusually ceases toward the end, when prostration is profound. The early vomiting is due to reflex causes, the later vomiting is due to waves of peristalis which produce regurgitation (Macready). The vomiting is first of the alimentary contents of the stomach, next of mucus and bilious matter, and finally of the contents of the small bowel (fecal or stercoraceous vomiting). Stercoraceous vomiting rarely arises until strangulation has lasted forty-eight hours, and may not appear until much later. "It is seldom met with in inguinal, more often in femoral, and more often still in obturator hernia" (Macready). Prostration is a marked symptom of a strangulated hernia, and it increases hour by hour and goes on to collapse. Early in the case there may be some elevation of temperature, but later it becomes normal or subnormal. The pulse is small, irregular, rapid, and very weak; the extremities cold; the face Hippocratic. Constipation is absolute, no gas even being passed, though in the very beginning there may be some diarrheal passages from below the constriction. Diarrhea with pain at a hernial orifice should always excite suspicion that strangulation may be beginning. The urine is scanty and high-colored, and contains only a small amount of the chlorids; the tongue becomes dry and brown; the thirst is torturing; and the patient often has an urgent desire to go to stool. Pains in the abdomen and in the hernia become violent, and collapse rapidly increases. When gangrene begins the symptoms apparently lessen in violence: there is a "delusive calm." Vomiting usually ceases, though regurgitation may take its place; hiccough begins; the pain abates or disappears; the pulse becomes very feeble and intermittent; collapse deepens, and delirium is usual. It is a safe clinical rule that in strangulated hernia cessation of pain without the relief of constriction, the disappearance of the lump, or the use of opiates means that gangrene has begun. In some cases of strangulation there are muscular cramps in the legs (Berger). In children convulsions are not unusual. In a pure omental hernia strangulation produces similar but less decided symptoms. It may be that only a portion of the circumference of the bowel is caught and constricted in a hernial orifice. Such a condition is encountered occasionally in the femoral ring, and is called partial enterocele or Richter's hernia.

The name Littre's hernia so often given to this condition is wrong. What Littre described was a hernia of Meckel's diverticulum. In a strangulated Richter's hernia constipation is rarely absolute and a protrusion is often undiscovered.

Treatment.—In treating strangulated hernia place the patient upon his back, bend the knees over a pillow, and rigidly interdict the administration of food. An attempt is to be made to effect reduction by gentle manipulation or taxis. In applying taxis to a femoral or inguinal hernia, flex and adduct the thigh of the affected side. In applying taxis to an umbilical hernia, both thighs should be flexed upon the abdomen. Always lower the shoulders and head and raise the pelvis, and accomplish this by lifting the foot of the bed and placing pillows under the pelvis. In some cases raise the entire body, the head being lowered. Grasp the neck of the sac with the fingers and thumb of one hand, and employ the other hand to squeeze the hernia and urge it toward the belly. In direct inguinal hernia the pressure should be backward and a little upward; in umbilical hernia it should be backward; in oblique inguinal hernia it should be upward, outward, and backward; in femoral hernia it should be downward until the hernia enters the saphenous opening, and then "backward toward the pubic spine" (MacCormac). If the bowel is reduced, it passes from the hand with a sudden slip and enters the belly with an audible gurgle; omentum, when reduced, slowly glides back without gurgling. Taxis is never to be continued long, and it is not even to be attempted in cases of great acuteness, in cases where strangulation has lasted for several days, in cases known to have been previously irreducible, in cases associated with stercoraceous vomiting, or in an inflamed or gangrenous hernia.

If taxis fails, obtain the patient's permission to operate. Anesthetize; try taxis again while ether is being dropped upon the hernia to cause cold; if reduction fails, at once perform herniotomy. Taxis possesses certain dangers: it may rupture the bowel; it may rupture the neck of the sac and force the bowel through the rent; it may strip the peritoneum from around the hernial orifice and force the bowel between the detached peritoneum and the abdominal wall; it may reduce a hernia into the belly when the bowel is still strangulated by adhesions; it may reduce the hernia *en masse* or *en bloc*, the sac and strictured bowel being forced together through the internal ring. By reduction *en bissac* is meant the forcing of a congenital hernia into a congenital pouch or diver-

ticulum. In any of the above accidents strangulation may persist after apparent reduction by taxis, and this condition calls for instant laparotomy—in most instances through the hernial aperture. If taxis is successful, put the patient to bed, apply a pad and bandage, allow the patient to take no food until vomiting ceases, merely permitting him to suck bits of ice, and keep him on a liquid diet for several days. At the end of the first week give solid food. Do not disturb the bowels for a few days, but if they have not acted at the end of four or five days, give a saline cathartic and an enema.

Herniotomy.—If there has been stercoraceous vomiting, the stomach must be washed out before giving the anesthetic, and during the administration of the anesthetic the head should be turned upon its side. In most cases a general anesthetic can be given, but in some desperate cases it is not justifiable to give ether or chloroform, and a local anesthetic must be used (eucain, cocain, or Schleich's fluid). Wrap the patient up warm. In most cases try gentle taxis for a brief time after the patient has been anesthetized, and while ether is being dropped upon the hernia to cause cold. Never try taxis if stercoraceous vomiting has occurred. If taxis fails, at once resterilize the parts and operate. The instruments required in herniotomy are a scalpel, a hernia-knife and director (Fig. 321, B), hemostatic and dissecting-forceps, blunt hooks, scissors, a dry dissector, partly curved needle, and a needle-holder. Drainage-tubes should be ready. In the *operation* the patient lies upon his back with the shoulders raised, the surgeon standing to the patient's right side. In *oblique inguinal hernia* it has been the custom since the days of Scultetus to raise a fold of skin at right angles to the axis of the external ring and transfix it, the wound which results being extended until it becomes three inches in length. This incision possesses no special merit. It is better to cut from without inward, and to make the same incision as for the performance of a radical cure in a non-strangulated case. The tissues are divided until the sac is reached, and no attempt is made to specially identify them. The sac is known by the fat which usually covers it, by the arborescent arrangement of its vessels, by the fact that it can be pinched up between the finger and thumb and the layers rolled over each other, and by the fluid within the sac. Should the sac be opened? In very recent cases it is usually unnecessary, but if there is any doubt as to the condition of the bowel, or if a radical cure is to be attempted, open the sac and be certain as to the condition of its contents. The general rule

should be to open the sac. The sac is opened and the contents examined for fecal odor (which is not unusual) and for gangrenous smell; the thickness of the bowel is estimated, and the color and luster are determined. In oblique inguinal hernia, nick the constriction upward and outward, as shown in Fig. 325. In direct inguinal hernia the cut is made upward and inward. Always pull the bowel down and examine the seat of constriction to see what damage has been inflicted at that point. If the bowel glistens, if the proper color comes back after irrigation with very hot water, and if there are no spots of gangrene, restore the bowel to the abdomen, and do a radical cure. If the bowel is in a doubtful condition, fasten it to the incision, apply a dressing, and watch the development of events. If the bowel is gangrenous, our action depends upon the condition of the patient. If the patient is in good condition, resect the gangrenous portion, and perform end-to-end anastomosis by means of a Murphy button. If the patient's condition is bad, make an artificial anus, and at a later period perform anastomosis. An artificial anus can be made by the method of Bodine (page 851). In most cases in which it seems necessary to make an artificial anus do not open the bowel at once, because it may recover in a day or two, when it can be restored to the belly; or it may slough and form an artificial anus. In such doubtful cases fasten the bowel to the belly-wall with sutures, dust it with iodoform, dress it with hot antiseptic fomentations, and await future developments. Gangrenous omentum requires ligation and resection. If the bowel is fit to reduce, push it just inside the ring, irrigate the parts, insert a drain, and suture. In most cases perform a radical cure. In *femoral hernia* we can make the incision one inch internal to, and parallel with, the femoral vessels, and crossing the tumor and ligament (Barker); but it is better to make the incision of Fabricius for radical cure. Divide the constriction by cutting upward and a little inward. In *umbilical hernia* make a slightly-curved incision a little to one side of the middle of the tumor, open the sac, separate adhesions, and divide the constriction by cutting upward or downward, and sometimes also laterally.

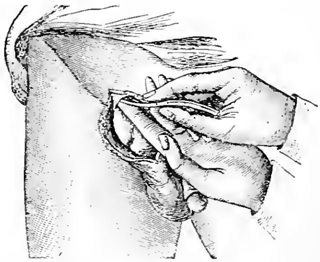


FIG. 325.—Herniotomy in inguinal hernia.

After an operation for strangulated hernia put the patient to bed; bend the knees over a pillow; give no food by the mouth for thirty-six hours (MacCormac), only allowing the patient bits of ice to suck; give nutrient enemata containing brandy. Abdominal pain and tenderness call for the administration of saline cathartics and enemata containing turpentine or oil of rue. The enema rutæ is a favorite preparation in St. George's Hospital, London. It is made as follows: Take sixteen ounces of an infusion of chamomile, warm it, and pour it upon ʒiij of confection of senna (Sheild). If there is no abdominal pain and tenderness, the bowels need not be disturbed for a few days; but if at the end of four or five days they have not acted, give a saline cathartic and an enema. Remove the drainage-tube on the third day. At the end of about three weeks, if a radical cure has not been attempted, get the patient up, first applying a pad and a spica bandage to the groin, and later a truss. If a radical cure has been made, the patient should stay in bed for one month. A truss should not be worn if a radical cure has been made.

Varieties of Hernia.—In *direct inguinal hernia* the bowel passes out through Hesselbach's triangle internal to the deep epigastric artery. It enters the inguinal canal low down, and passes outside the conjoined tendon or forces the conjoined tendon before it or splits through the tendon. The neck of the sac is internal to the deep epigastric artery. The coverings of this hernia, when it passes external to the conjoined tendon, are the same as those of an indirect inguinal hernia; when a direct hernia pushes before it the conjoined tendon, its coverings are skin, superficial fascia, intercolumnar fascia, conjoined tendon, transversalis fascia, subserous tissue, and peritoneum.

In *indirect inguinal hernia* the bowel passes through the internal abdominal ring external to Hesselbach's triangle and external to the deep epigastric artery. It passes down the inguinal canal and emerges from the external ring; it may enter the scrotum or labium (scrotal or labial hernia), or it may not. The neck of the sac is external to the deep epigastric artery. Its coverings are skin, superficial fascia intercolumnar fascia, cremaster muscle, infundibuliform fascia, subserous tissue, and peritoneum.

Congenital inguinal hernia is a portion of bowel within an unclosed vaginal process. The bowel in congenital hernia has one layer of peritoneum in front of it. The testicle is posterior and below (Fig. 326). Always remember that con-

genital hernia may not appear for several months after birth. Congenital hernia conceals or buries the testicle; acquired hernia does not. If a vaginal process open above and closed below contains a hernia, the condition is called hernia into the funicular process.

If the funicular process is closed at the abdominal end but not below, a hernia in a special sac may descend back of the vaginal tunic. This condition is known as *infantile hernia*. In infantile hernia there are three layers of peritoneum in front of the bowel, the two layers of the vaginal

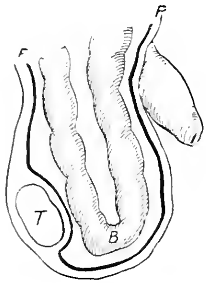


FIG. 326.—Congenital hernia: *T*, testicle; *F.P*, funicular process; *B*, bowel.

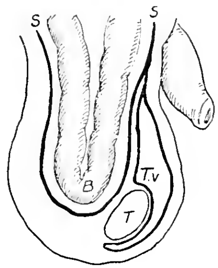


FIG. 327.—Infantile hernia: *T*, testicle; *T.V*, tunica vaginalis; *S.S*, sac; *B*, bowel.

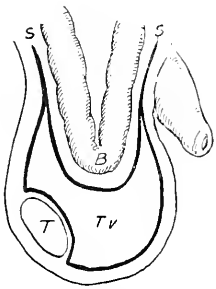


FIG. 328.—Encysted infantile hernia: *T*, testicle; *T.V*, tunica vaginalis (represented as distended); *S.S*, sac; *B*, bowel.

tunic and the one layer of sac. The testicle is in front (Fig. 327).

If the tunica vaginalis is closed above and not below, and a hernia pushes down the vaginal process and causes it to double on itself, the condition is known as *encysted infantile hernia* (Fig. 328).

In *femoral hernia* the bowel descends along the femoral canal, and the neck of the sac is at the femoral ring. The neck of a femoral rupture is always external to the pubic spine; the neck of an inguinal rupture is always internal to the pubic spine. Femoral hernia is never congenital. Its coverings are skin, superficial fascia, cribriform fascia, crural sheath, septum crurale, subserous tissue, and peritoneum.

Umbilical hernia may be congenital (the ventral plates having closed incompletely), infantile (the cicatrix of the umbilicus having stretched), or acquired.

Ventral hernia is a protrusion through any part of the anterior abdominal wall except at the umbilicus or above it.

Epigastric hernia is a protrusion of peritoneum in the space

bounded by the ensiform cartilage, the ribs, and the umbilicus. The sac of peritoneum may be empty, may contain omentum, or omentum and bowel. The stomach very rarely passes into the sac. The protrusion is usually, but not invariably, through the linea alba.

In *properitoneal hernia* the sac is between the peritoneum and transversalis fascia. This form of hernia is sometimes produced by making taxis on an inguinal hernia, when the internal ring is small or is blocked by an undescended testicle. In properitoneal inguinal hernia, which is the most common form, there are two sacs detectable, one in the scrotum, the other parallel with Poupart's ligament, and as one sac is emptied the other distends (Breiter of Zurich).

Obturator hernia passes through the obturator membrane or the obturator canal, and is felt below the horizontal ramus of the pubes, internal to the femoral vessels.

Lumbar hernia occurs at the edge of or through the quadratus lumborum muscle.

Sciatic or *gluteal hernia* passes through the great sacrosciatic foramen, above or below the pyriformis muscle.

In *diaphragmatic hernia* some viscera of the abdomen pass through a natural or accidental opening into the thorax. It is most common on the left side.

Pudendal hernia protrudes into the lower part of the labium, the bowel having descended between the ischial ramus and the vagina.

Perineal hernia presents in the perineum, between the rectum and the prostate gland or between the rectum and the vagina.

Hernia into the foramen of Winslow is very rare. Herniæ rarely occur into the *retroduodenal fossæ*, the *retrocæcal fossæ*, and into the *intersigmoid fossa*.

Vaginal hernia is associated with uterine prolapse or ensues upon destruction of the vaginal wall.

Rokintansky's diverticular herniæ are due to separation of the muscular fibers of the bowel permitting the sacculation of mucous membrane and peritoneum. These false diverticula may be no larger than peas or may be larger than walnuts, and there may be scores of them in one patient. They may produce no symptoms, or may lead to peritonitis or to symptoms of intestinal obstruction.

Hernia of the Bladder.—This is a protrusion of a portion of the bladder-wall through a hernial opening. The protrusion may or may not be covered with peritoneum.[1] It

[1] Brunner, in *Deutsch Zeitschr. f. Chir.*, 1898, vol. xlvii.

is most frequently met with in the inguinal region. Brunner describes three forms: 1. Entirely without a peritoneal covering (extraperitoneal); 2. Partly covered with peritoneum (paraperitoneal—the commonest form); 3. Completely covered with peritoneum (intraperitoneal). The bladder may constitute the hernia, or there may be an ordinary hernia, and also a cystocele. In an inguinal hernia the bladder will be internal and somewhat behind the other constituent parts of the protrusion. Hernia of the bladder is much more common in men than in women.

A hernia of the bladder may become strangulated. In some cases a diagnosis of hernia of the bladder can be made by the fact that the protrusion lessens in size when the patient micturates and increases in size as urine gathers, or when the bladder is injected with fluid. The treatment should be operative. When the bladder is exposed, it is replaced with or without resection of a portion.

XXVIII. DISEASES AND INJURIES OF THE RECTUM AND ANUS.

Examination of the Rectum.—Whenever possible, have the bowels emptied before an examination by the administration of a cathartic and the use of an enema.

Place the patient on the left side, with the knees drawn up and the pelvis elevated (the left-lateral-prone position of Sims). The anus is carefully inspected, the anal folds being opened during the process. By inspection the surgeon can notice the external opening of a fistula, external piles, protruding internal piles, mixed piles, pruritus, discharge from the rectum, eczema, fissure, tumor, ulcer, condylomata, or abscess.

Next, a digital examination of the rectum is made. The nail of the index-finger is filled with soap; the finger is oiled and is gently inserted through the sphincter, the patient being asked to strain lightly while it is passing. A digital examination enables the surgeon to detect an ulcer, a polypus, a tumor, a stricture, and to determine certain points regarding the condition of the prostate in the male and the uterus in the female.

Next, in some cases, the rectum must be examined with a speculum. It is not often necessary to give ether. Mathew's speculum (Fig. 329) is very serviceable. Sims's duckbill speculum is a valuable instrument. The speculum is warmed, oiled, and slowly introduced. It is first directed

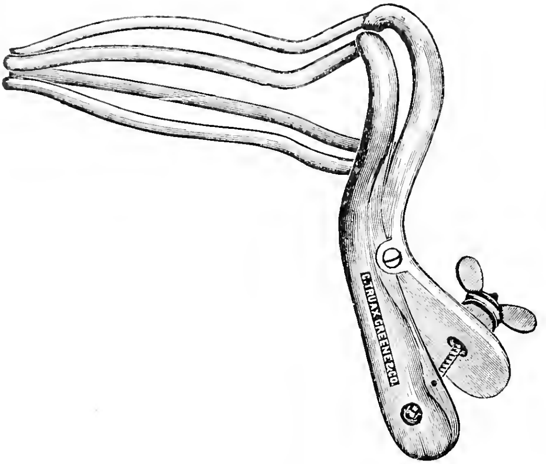


FIG. 329.—Mathew's self-retaining rectal speculum.

toward the umbilicus, and when it passes the sphincter its direction is gradually altered until it is toward the promon-

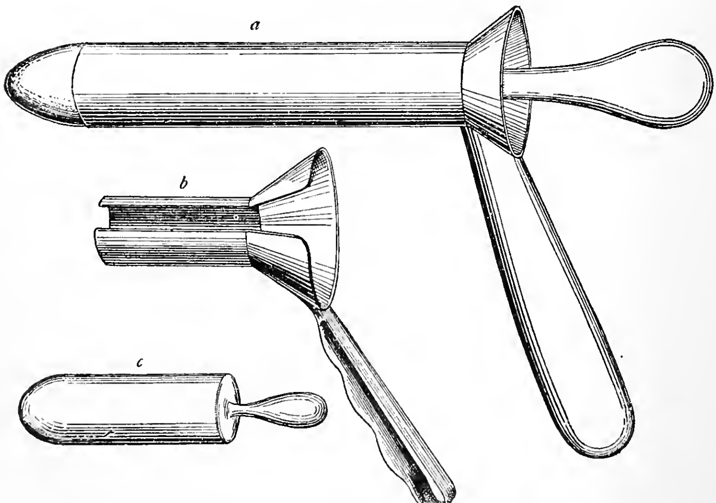


FIG. 330.—Kelly's rectal specula.

tory of the sacrum. Illumination is obtained by direct sunlight, or by a forehead mirror and an electric light. This examination will extend, confirm, or disprove the find-

ings of the digital examination; ulcers, hemorrhoids, and malignant growths can be carefully examined, and the condition of the rectal mucous membrane can be thoroughly investigated.

In some cases where a high examination is necessary Kelly's tubes are used (Fig. 330). It is not always necessary to give ether. The patient is placed in the knee-chest position (Fig. 331). A tube containing an obturator is

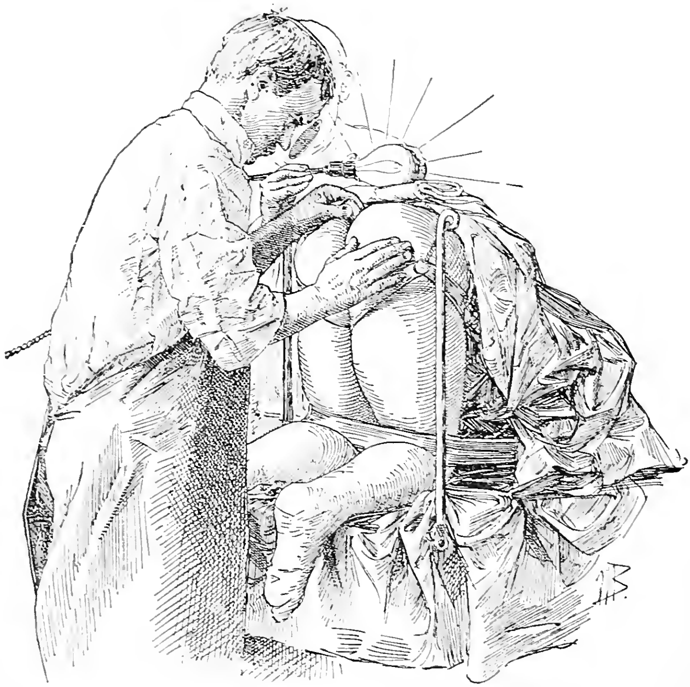
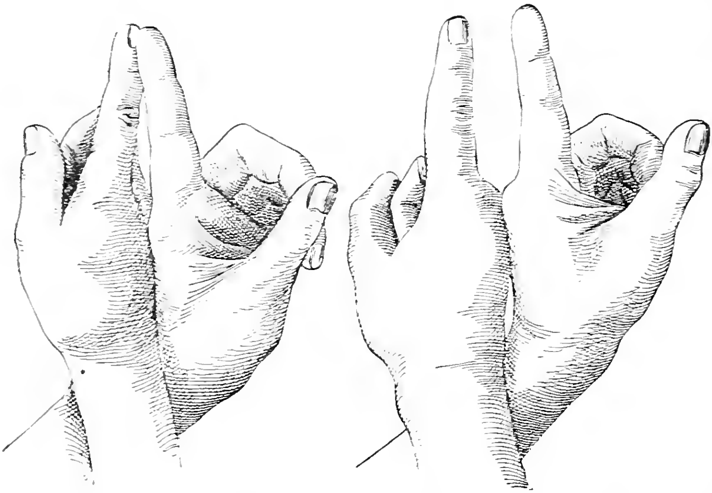


FIG. 331.—Examination of the rectum by reflected light (Kelly).

well greased with vaselin. "The buttocks are drawn apart, and the blunt end of the obturator is laid on the anus, which is also coated with vaselin. The direction of the instrument should be first downward and forward, and, when the sphincter is well passed, up under the sacral promontory. The moment the speculum clears the sphincter ani and the obturator is withdrawn air rushes in audibly and distends the bowel." The bowel being distended with air, the mucous membrane is plainly seen as the tube is slowly withdrawn and the light is reflected into the speculum. The Kelly

tube must be used with great care, as harm may be done by it, and the long tube should only be used in exceptional cases.

If a patient is placed in the knee-chest position and anesthetized, the sphincter can be stretched by the fingers, and the rectum will distend with air and can be easily examined. The fingers are introduced as suggested by Martin (Fig. 332),



FIGS 332, 333.—A new and simple method of proctoscopy (Thomas C. Martin).

and the rectum becomes visible when they are separated (Fig. 333).

Hemorrhoids, or Piles.—There are three varieties of varicose tumors of the rectum, namely: *internal*, which take origin within the external sphincter; *external*, which take origin without the external sphincter; and *mixed* hemorrhoids, which are a combination of the two.

External hemorrhoids are covered with skin. Internal hemorrhoids are covered with mucous membrane. The term external hemorrhoids is not strictly accurate, as hemorrhage does not occur in external piles, and all external piles are not related to the external hemorrhoidal veins. An external pile may involve the veins or the skin. If the veins are involved, there may be varicosity of the plexus, a condition due to straining, often associated with internal piles and productive of no particular annoyance. Symptoms appear when phlebitis arises; phlebitis causes thrombus, and the vein commonly ruptures.

External Hemorrhoids.—When a vein inflames the parts are itchy, painful, and swollen, and defecation increases the pain. When the vein ruptures a livid, soft enlargement appears near the edge of the anus, accompanied by decided pain and other evidences of inflammation. These blood-tumors may get well if let alone, or they may suppurate. External piles are apt to be multiple, and cause no pain except when inflamed. When the superfluous tags of skin around the anus enlarge, they give rise to much pain and inflammation. These cutaneous outgrowths are often spoken of as a form of external piles; they are due to some inflammation, and are frequently secondary to inflammation of the anus or in the rectum.

Symptoms and Treatment.—An inflammatory enlargement is detected, which is tender and painful. Pain is increased by defecation. These piles do not bleed. In treating external hemorrhoids some surgeons merely use remedies to combat the inflammation. An old plan of treatment is to incise the blood-tumor, turn out the clot, and pack with a bit of iodoform gauze. Mathews freezes the part or injects cocain, catches up the blood-tumor with a volsellum, excises the tumor and the tabs of inflamed skin, dusts the part with iodoform, and dresses it with antiseptic gauze. The bowels should not be allowed to move for two days. Never inject external piles with carbolic acid; it causes great inflammation, excessive pain, and is not free from danger. If the patient declines operation, order rest, a non-stimulating diet, avoidance of tobacco (Mathews), the use of saline purgatives, injections into the rectum of cold water several times a day, sponging of the anus frequently with hot water, and the application of hot poultices. As the acute symptoms begin to disappear use lead-water and laudanum; when they have nearly subsided apply zinc ointment. Extract of hamamelis is a valuable application to external piles.

Internal hemorrhoids are varicose tumors of the internal hemorrhoidal plexus, and are found internal to the external sphincter, just within the anus, and they prolapse easily. They are not simple varicosities, but new tissue has been formed, and they are in reality vascular tumors. They are covered with mucus membrane. *Capillary* piles are small, sessile, with a surface like a mulberry, and bleed freely. Children are not very liable to develop piles excepting the capillary form. *Venous* piles are the most common variety. They extend from just above the anal margin of the rectum for an inch or more. They are purple in color, soft, irregular

in outline, and are usually multiple. They bleed when irritated by hard fecal masses, but not so easily as the capillary piles. Each pile is composed of a varicose vein, some fibrous tissue, and a few arterial twigs. *Arterial* piles are very unusual. They are large, smooth, pedunculated, bleed easily and freely, and contain, besides a distended vein, arteries of some size.

Anything producing venous congestion in the rectum—constipation, diseases of the rectum, enlargement of the prostate, pregnancy, tumors of the womb, congestion of the liver, cirrhosis of the liver, certain diseases of the heart and lungs, sedentary occupations, relaxing climate, and stricture of the urethra—will cause hemorrhoids.

Symptoms and Treatment.—If there is no bleeding and no protrusion, the piles give no trouble. The first symptom is usually hemorrhage, and rectal examination by the finger and by the speculum will make clear the condition. After a time, during defecation, the piles protrude; they may reduce themselves when the patient stands up, or it may be necessary to push them in. Pain does not exist in uncomplicated cases, and pain during or after protrusion means "abrasion, fissure, or ulceration" (Mathews). *Palliative treatment* will not cure, but it will give great comfort. Some people only suffer at rare times when the liver is congested, and such subjects will not submit to operation. Remove, if possible, the cause (alcohol, irritating foods, want of exercise, etc.); restrict the diet; insist on regular exercise; give a course of Carlsbad salt, and follow this by the stomach use of bichlorid of mercury (gr. $\frac{1}{24}$ after each meal). Prevent constipation by a nightly dose of fluid extract of cascara. After each movement wash the parts and syringe out the rectum with cold water, and dry outwardly with a soft rag. If the hemorrhoids prolapse, after restoring them and injecting water, insert a suppository containing gr. v of the extract of hamamelis, and use another suppository at bedtime. When the piles prolapse and inflame, rub Allingham's ointment on the parts (ʒij each of ext. of conium and ext. of hyoscyamus, ʒj of ext. of belladonna, and ℥j of cosmolin). Mathews uses gr. xij of cocain, ʒj of iodoform, ʒss of ext. of opium, and ℥j of cosmolin. If the piles are protruding and reduction cannot be effected, put the patient to bed, give a hypodermatic injection of morphin, and apply hot poultices. If reduction cannot soon be effected, operation must be resorted to.

Operative Treatment.—Give a saline the morning before,

and an enema the evening before the operation, and wash out the rectum well the morning of the operation. In treating by *injection of carbolic acid* the tumors are drawn out or the patient strains them out, an injection is given by a hypodermatic syringe into the center of the pile, and as each pile is injected it is pushed into the rectum. The dose for each pile is 10 drops of a solution containing 3 parts of glycerin, 3 of water, and 1 of pure carbolic acid. The injection is rarely curative, is very painful, and may produce hemorrhage, phlebitis, pyemia, stricture, and even death (W. T. Bull). The *clamp and cautery* may be used in interno-external piles. The patient is anesthetized, the sphincter is stretched, and the pile is caught with forceps and drawn outside of the sphincter. Smith's clamp is applied with the ivory surface against the mucous membrane of the bowel, the pile is cut off, and the stump is seared with the Paquelin cautery at a dull-red heat. *Excision* is preferred by Allingham. He stretches the sphincter,

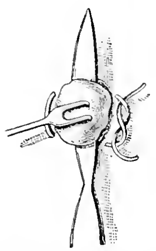


FIG. 334.—Extirpation of hemorrhoids (Esmarch and Kowalzig.)

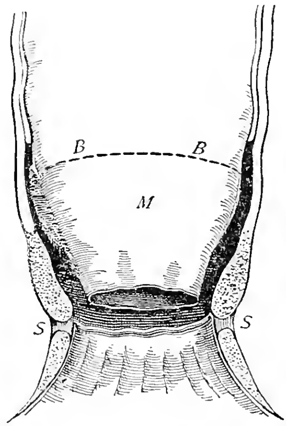


FIG. 335.—*SS*, the lower circular incision along Hilton's white line; M, tube of mucous membrane dissected from the sphincter; *B B*, dotted line showing the place for the upper circular incision (Edmund Andrews).

holds it open with a retractor, catches up the pile, cuts it off, and twists the bleeding vessels. Some prefer to pass a silk or catgut suture, cut off the tumor, and tie the thread (Fig. 334). *Whitehead's operation* is suited to severe cases, when the piles are extremely large and form a protruding circular mass. Only a surgeon who can master violent hemorrhage should venture to perform it. The entire pile-bearing area of mucous membrane is dissected out, and the cut margin of mucous membrane is pulled down and stitched to the surface. The sphincter may be dilated as a preliminary measure (Fig. 335). This operation is sometimes followed

by disastrous consequences, especially by fecal incontinence.[1]

The *application of the ligature* is the easiest and most generally useful method. In this operation, after anesthetizing, stretch the sphincter and treat each hemorrhoid separately. Catch a pile with a pair of forceps or a volsellum, pull it down, and cut a gutter through the skin-margin if the pile is of the mixed variety; tie the small piles without transfixing, but transfix the large piles; tie with silk (coarse silk for the large piles, finer silk for the small piles); cut off the tumor beyond the thread, and cut the ligatures short. Treat the other piles in the same manner. Irrigate with hot normal salt solution, dust with iodoform, pack a piece of iodoform gauze into the rectum, and apply a gauze pad and a T-bandage. Give some morphin to lock up the bowels, and keep the patient on a light diet for three days, at the end of which time a saline may be given. Just before the bowels act remove the dressings and give an enema of warm water. After the movement wash out the rectum first with peroxid of hydrogen and next with hot salt solution, dust with iodoform, and apply a gauze pad over the anus. Irrigate daily until healing is complete. After the tenth day examine with a speculum to see that the ligatures have come away; if any are found in place, remove them.

Prolapse of Anus and Rectum.—If the mucous membrane is prolapsed, the condition is called "prolapsus ani;" if the entire thickness of the rectal wall is prolapsed, it is called "prolapsus recti." Prolapse, which is apt to occur from excessive straining at stool, is commonest in feeble, ill-nourished children. Piles and worms may be complicated with prolapse. Straining from phimosis, stone in the bladder, or stricture may be causative. Prolapse may be either large or small, but tends to recur again and again, and eventually the mucous membrane inflames, ulcerates, or sloughs. Strangulation of the prolapsed part may occur.

Treatment.—*Palliative* treatment forbids straining at stool. If prolapse occurs, the protrusion must be bathed with cold water and restored. Constipation must be prevented (enemata of water or glycerin may be used). If a prolapse is caught firmly, place the patient in the knee-chest position, wash the mass with cold water, grease it with cosmolin, insert a finger into the rectum, and apply taxis around the finger (Mathews). If this fails, cover a finger with a hand-

[1] Andrews, in *Mathew's Medical Quarterly*, Oct., 1895.

kerchief and insert the wrapped digit into the rectum; if this proves futile, invert the patient. Severe cases require ether before reduction is attempted. After reduction apply a compress, direct it to be worn except when at stool, and before each act of defecation give an injection of cold water containing an astringent (tannin or fluid ext. hydrastis). Some cases require excision of the mucous membrane, the divided edge of this membrane being stitched to the skin. In other cases the protrusion is stroked with the cautery and restored. In persistent cases of rectal prolapse open the abdomen and attach the colon to the belly-wall (colopexy, Fig. 336).

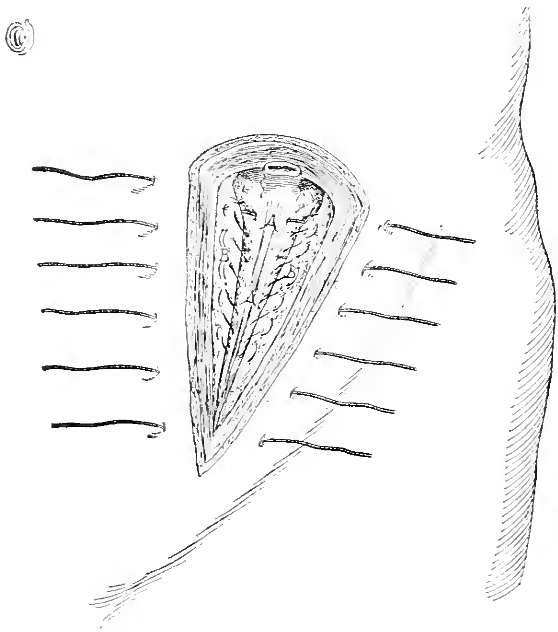


FIG. 336.—Joseph Bryant's method of colopexy: *A*, *A*, longitudinal band, with sutures passed behind it, including peritoneal and muscular coats of the intestines, drawn forward; *B*, *B*, parietal peritoneum quilted to sides of the intestine, showing stitches; *C*, old fecal fistula.

Ulcer of the Rectum.—Ulcers of the rectum are divided into the simple traumatic, the syphilitic, the tubercular, the dysenteric, the gonorrheal, and the malignant. The *simple* ulcer is due to abrasion with fecal masses or a foreign body, the abraded area ulcerating. It may follow an operation for piles and also protracted labor (Allingham). A simple ulceration is apt to be single. The base and edges of a simple

ulcer are neither prominent nor hard. *Syphilitic* ulcer is a tertiary lesion commonest in women. There are numerous small ulcers of the mucous coat or submucous tissue, but little indurated, with sharp-cut edges which are not undermined. These ulcers fuse and constitute one large irregular ulcer; fibrous tissue forms in the wall of the bowel, induration becomes noticeable, and stricture follows. There is profuse discharge, and fistulæ are apt to form. Such ulcers may be surrounded by nodules of a bluish color. The first condition is often stricture due to the formation of masses of fibrous tissue in the rectal walls, which may ulcerate (Fournier). In syphilis there may be a breaking down of a huge gummy mass or of multiple gummata. It has been proved by the microscope that tubercular ulceration may arise in the rectum. *Tubercular* ulceration presents a conical ulcer with overhanging edges and a pale-red base. There is some mucous discharge, some tenesmus, and a little pain. Dysentery, catarrh, neoplasms, and foreign bodies produce ulceration. The **symptoms** are constipation, burning pain during or after defecation, straining at stool, and blood and mucus in the stools. The **diagnosis** is made by digital examination and inspection through a speculum.

Treatment.—In *simple* ulcer empty the bowel by the administration of a saline cathartic, wash out the rectum with hot water after the saline has acted, introduce a speculum, touch the ulcer with pure carbolic acid or silver nitrate (gr. xl to ℥j), place the patient in bed, restrict him to a liquid diet, and every day inject iodoform and olive oil or insufflate iodoform into the rectum. If this fails, give ether, stretch the sphincter, incise the ulcer through its entire thickness, and cauterize with fuming nitric acid, caring for the case subsequently as we would a patient who had had piles ligated. In *tubercular* ulcer improve the general health, send the patient to a genial climate, or at least into the sunlight and fresh air, prevent constipation, give nutritious food, especially fats, wash out the rectum every day with hot water and insufflate iodoform or inject iodoform emulsion. Touch the ulcer once a week with silver nitrate (gr. x to ℥j). In *syphilitic* ulcer give antisyphilitic treatment and treat the ulcer locally as is done in tubercular ulcer. *Dysenteric* ulcer requires injections of hot water, the touching of the ulcer with pure carbolic acid, and insufflations of iodoform.

Non-cancerous stricture of the rectum may be congenital or acquired. There are two forms of acquired stricture: first, stricture due to external pressure; second, stricture due to

primary narrowing of the rectal wall.[1] Stricture due to external pressure is very rarely complete, and may be caused by bands of adhesions or a malignant growth. The second form may be produced by syphilitic tissue, ordinary inflammatory tissue, cicatrices after operations, sloughing, tubercular, syphilitic, or dysenteric ulceration, rectal gonorrhea, and traumatism. The usual seat of simple stricture is from one inch to one and a half inches above the anus. The deposit may be limited to the submucous coat or all the coats may be involved. It is very rarely that stricture arises as a result of abrasion from fecal masses or foreign bodies. It may follow an operation for piles if considerable tissue is removed, and is an occasional sequence of Whitehead's operation. Stricture due to dysentery is extremely rare, and no case has ever been reported to the U. S. Pension Office (Peterson). The existence of stricture as a result of rectal gonorrhea has not been positively proved. A majority of sufferers from rectal stricture have labored under syphilis, but it is not probable that the lesion is syphilitic in all or even in most of them. The stricture may be due to the formation of fibrous tissue, and ulceration may or may not occur. It may be caused by the contraction and healing of a large ulcer. There is no doubt that tubercular stricture does occur. Peterson[2] says a large proportion of the victims of rectal stricture die of phthisis, and also that one-third of so-called syphilitic cases are tubercular. It may begin as an ulcer or as an infiltration of submucous tissue. Although a syphilitic lesion or a tubercular lesion may cause rectal stricture, in some cases such lesions simply expose the tissues to infection, and a benign rectal stenosis results.

The **symptoms** of rectal stricture are constipation, pain on defecation, straining at stool, the presence of blood and mucus in the stools, an open anus, and the passage of stools flattened out into ribbons. The stricture is found by the finger or by the bougie. In syphilitic cases, tubercular cases, and in benign cases the fibrous thickening is usually in the submucous coat, and in syphilitic and tubercular cases the mucous membrane is apt to ulcerate. Complete obstruction may come on, and distended abdomen with colic is very usual. Cancer is described on p. 886.

The **treatment** of non-cancerous stricture is rest, non-stimulating diet, warm-water injections, mild laxatives, and hot hip-baths. Cocain suppositories may be needed. Any existing disease is treated. Bougies are passed every other day.

[1] Reuben Peterson, in *Jour. Amer. Med. Assoc.*, Feb. 3, 1900. [2] *Ibid.*

Use a soft-rubber bougie, warmed and oiled, and introduce it gently. If only the method of gradual dilatation is employed, the patient must for the remainder of his life pass a bougie from time to time. For fibrous strictures forcible dilatation (divulsion) by a special instrument is employed or incision is practised. Incision (proctotomy) may be either external or internal. In internal proctotomy one or more incisions are made through the stricture down to healthy tissue, the first cut being in the middle line posteriorly. External proctotomy, which divides the sphincters, is apt to leave incontinence as a legacy. Electrolysis finds some advocates, but on what grounds it is difficult to see. In some cases the rectum should be removed. In incurable cases perform inguinal colostomy.

Cancer of the rectum is the cancer of the bowel most often met with. It may be primarily malignant or may arise from an adenoma. The commonest growths are composed of cylindrical cells, and may be soft or scirrhous. In cases secondary to carcinoma of the anus ordinary epithelioma arises.

In most rectal carcinomata the cells present a tubular arrangement surrounded by a more or less plentiful stroma of connective tissue. In soft tumors the connective tissue is scanty, in hard tumors it is plentiful.

It not unusually occurs before the thirty-fifth year, and is seen as early as the twenty-fourth year. The retroperitoneal and inguinal glands are involved late or not at all. Extensive ulceration occurs. If a hard ring encircles the rectum, the lumen of the tube is greatly and progressively diminished. In cases of diffuse infiltration the lumen is not greatly lessened.

Symptoms and Treatment.—The *symptoms* of rectal cancer are like those of non-malignant stricture, except that the pain is greater, the hemorrhage more severe, and constipation is apt to alternate with diarrhea. The finger and the speculum make the diagnosis. In rectal cancer metastasis occurs late. The most favorable cases for operation are those in which the growth is small and movable. Accurately define the extent of the growth and endeavor to make out if it has invaded the cellular tissue outside of the rectum, the prostate, the bladder, the sacrum, the uterus, etc. Cases of widespread invasion should not be subjected to radical operation. *Palliative treatment* is as follows: every day introduce a tube through the stricture, wash out the rectum with warm water, and after washing inject emulsion of iodoform (gr. x to

℥j of sweet oil). Injections of chlorid of zinc (gr. j to ℥j of water) lessen the foulness of the discharge. Eventually colostomy is performed. This operation gives great comfort to the patient, and allays pain and prolongs life by intercepting the feces before they reach the cancer. This operation is employed for inoperable cancer, for obstruction, and in cases where metastasis has occurred. *Operative treatment* includes one of several procedures. Internal proctotomy does some good. Excision of the rectum from below (Cripp's operation) is practised if not more than three inches require removal, if the peritoneum is not invaded, and if the adjacent organs are free from disease. The peritoneum must not be opened in Cripp's operation. After the growth is removed

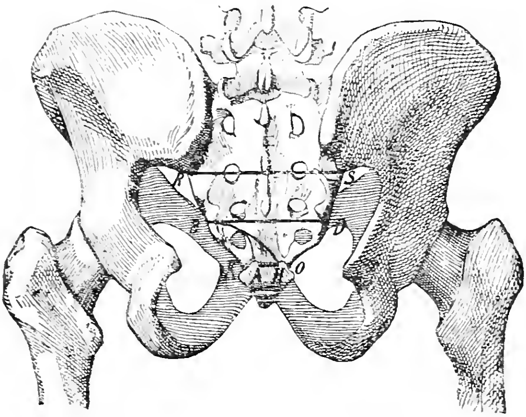


FIG. 337.—Different levels of resection of the sacrum: *KO*, Kocher's line; *BV*, Kraske's; *BH*, Hochenegg's; *BD*, Bardenheuer's; *RS*, Rose's (Maas).

the divided rectum is pulled down and sutured to the skin. Excision of the rectum after excising a portion of the sacrum (Kraske's operation, Fig. 337) is an operation which permits removal of the entire tube, portions of the colon, and even of adjacent parts. The peritoneum is opened deliberately in this operation, and is subsequently closed with sutures. The lower end of the upper segment of bowel is fastened in the wound, or, if colostomy has been previously performed, may be closed. In some few cases in which it is not necessary to remove the lower end of the rectum, the two portions may be anastomosed after resection of a part of the tube. Kraske's operation may be done by an osteoplastic method, the bone not being removed. It is well to precede a Kraske operation two weeks by an iliac colostomy, which

permits of cleansing the lower bowel from feces and lessens the chance of severe wound-infection and delayed healing after the removal of the rectum. A preliminary colostomy may make the operation of extirpation more difficult by fixing the intestine, and thus interfering with the necessary drawing down of the gut (E. H. Taylor). If the growth is extensive and the mesocolon short, it may be best to perform a right inguinal colostomy; but in most cases left inguinal colostomy is preferred (Gerster). The colostomy remains open during the patient's life, except in those rare cases of Kraske's operation in which the continuity of the rectum can be re-established after excision of the growth. In such cases the artificial anus is closed some time after the resection of the rectum.

Foreign bodies in the rectum, if small, are extracted with forceps and the fingers; if large, ether must first be given and the sphincter must be dilated.

Wounds of the rectum require free drainage, antiseptic irrigation, and antiseptic dressing. If the peritoneum is opened, laparotomy must be performed, the peritoneal cavity irrigated, the rectal wound sutured, and the abdomen drained.

Ischiorectal abscesses are situated in the ischiorectal fossa. They travel in the line of least resistance, which is upward, and more often burst into the bowel than externally. They are caused by cold, by external traumatisms, by perforations of the rectum by hard fecal masses, or by the passage of bacteria into the fossa through a fissure, an ulcer, or an ulcerated pile. They may be either acute or tubercular. The **symptoms** are the same as those of abscess anywhere, the swelling, however, being brawny and fluctuation being hard to detect. Pain in the groins is often complained of, and there may be enlarged glands in these regions.

The **treatment** is instant incision, the cut radiating from the anus like the spoke of a wheel. Incision is followed by irrigation and packing with iodoform gauze or the insertion of a drainage-tube.

Imperforate Anus.—There are two forms of this condition. In one form the rectum empties into the bladder, vagina, or urethra. In the other form there is no rectal opening either upon the surface of the body or in the urinary organs. The diagnosis is usually at once apparent, except in cases where the anus looks normal, when the diagnosis will often not be made until symptoms of obstruction arise.

Treatment.—If the rectum bulges when the child cries, open into it with a knife and keep the opening patent by inserting a plug of iodoform gauze. In cases in which the

rectum is more deeply seated a catheter is introduced into the bladder, an incision is made from the anus to the coccyx, the rectum is sought for, and when found is sewed to the anus, and is incised. In some cases Keen and others have performed Kraske's operation, pulling down the rectum to the anal margin, sewing it there, and incising the occluded anus. If the rectum cannot be found or cannot be pulled down, an artificial anus must be made.

Fistula in ano is the track of an unhealed abscess. An abscess in the anal region is apt to refuse to heal because of the constant movement of the parts (produced by respiration, coughing, the passage of gas, defecation, etc.). The passage of feces will keep a fistula open. If a tubercular ulcer perforates, a tubercular sinus forms, and a tubercular sinus is also apt to follow a cold abscess of the ischiorectal space. Fistula is often associated with phthisis pulmonalis, and is not unusually linked with piles, cancer, or stricture.

There are three varieties of fistula—the blind external (Fig. 338, A), the blind internal (Fig. 338, B), and the complete (Fig. 338, C). The *external* opening is usually near the anus, but may be far away, and there may be only one path-

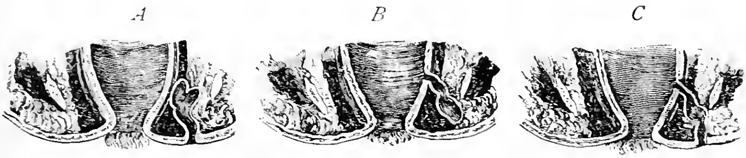


FIG. 338.—Fistula in ano: A, blind external; B, blind internal; C, complete (Esmarch and Kowalzig).

way or there may be several sinuses. In a healthy individual the external orifice is small and a mass of granulations sprouts from it. In a tubercular fistula the external orifice is large and irregular, with thin and undermined edges, shows no granulations, extrudes small quantities of sanious pus, and the skin about it is purple and congested. In a fistula following an anal abscess the *internal* opening is just above the anus, between the two sphincters. In fistula following an ischiorectal abscess the internal opening may be above the internal sphincter. A sinus may run up under the mucous membrane from the internal opening. In a horseshoe fistula the internal opening is usually upon the posterior wall of the bowel, "and from this a tract leads into the ischiorectal fossa, not on one side only, but upon both. Therefore we have one opening into the bowel and one through the skin

on either side."[1] In some cases of horseshoe fistula there is no internal opening; in other cases there are two openings. In an old fistula the track becomes fibrous and cannot collapse. Two or more fistulæ may exist in the same patient. In dealing with a fistula always determine if the condition is stationary or progressive. The **symptoms** of a complete fistula are the passage of feces and gas through the opening and the flow of a discharge which stains the clothing. In a complete fistula a probe can be carried from the external opening into the bowel. After a time incontinence of feces is apt to come on, repeated attacks of inflammation thickening the rectum and destroying its sensibility. From time to time the opening will block, and new abscesses form. In examining a fistula use Brodie's probe, as its flat handle enables one to locate the direction the bent instrument has taken, and its slender shaft will find its way through a very small channel.

Treatment.—In treating a fistula cleanse the parts, as cleanly work, though it will not prevent pus, will limit suppuration. The external parts are washed with soap and water. The rectum, which must be empty, is irrigated with hot saline solution. Corrosive sublimate should not be used in the rectum, because it is irritant, causes a flow of serum, and hence lessens tissue-resistance, and is rendered inert as an antiseptic by being converted into sulphid of mercury. Anesthetize the patient. If operating upon a complete fistula, pass a grooved director into the external opening, carry it through the sinus, make it enter the bowel, bring its point out externally, and lift the tissues between the sinus and the surface. Incise the tissues (Fig. 339). Cut the sphincter at a right angle to its fibers, and do not cut it more than once at one operation. Push the finger to the depth of the wound, to determine that the sinus does not ascend above the internal opening. If there are two fistulæ, cut one through, and when one heals cut the other. In some straight sinuses the tract can be extirpated and the parts sutured, primary union occasionally resulting. Look for branching sinuses, and if any are found slit them open. Examine carefully to see if there is a sinus beneath the

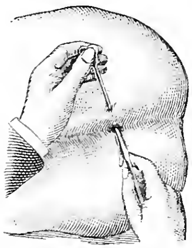


FIG. 339.—Operation for fistula in ano (Esmarch and Kowalzig).

[1] *Diseases of the Rectum, Anus, and Sigmoid Flexure*, by Joseph M. Mathews.

mucous membrane of the bowel, and if such a sinus is found slit it up. Curet all sinuses, and if they are very fibrous clip them away with scissors. Cut away diseased skin; irrigate with salt solution; pack with iodoform gauze; and dress with gauze and a T-bandage. In forty-eight hours remove the dressings, spray with peroxid of hydrogen and irrigate with salt solution, dust with iodoform, insert lightly to the depths of the wound a piece of iodoform gauze, and reapply the dressings. Dress the wound thus every day until healing is almost complete. It is unnecessary to confine the bowels beyond forty-eight hours, at which period, if they have not moved, an enema is given. If the dressing at any time becomes stained with feces, re-dress at once. Get the patient out of bed as soon as possible.

If a blind external fistula does not heal, every sinus must be incised, and thickened walls must be cut away or scraped away.

In a blind internal fistula an external incision is made to convert the case into a complete fistula, which is then treated as is directed above.

In horseshoe fistula, more than one operation may be necessary in order to avoid cutting the sphincter muscle twice in one operation, a proceeding which would probably lead to fecal incontinence. One side alone is operated on. Sinuses are opened and scraped, the sphincter is divided, the angles and edges of skin are trimmed away, and the wound is packed. When the wound is healed, or nearly healed, the other side should be operated upon.

If fecal incontinence results from an operation for fistula, remove the scar-tissue and endeavor to suture the separated muscular fibers. Should an operation be undertaken for fistula if phthisis exists? Many of the old masters said *no*. Mathews sums up the modern view: in incipient phthisis operate; in rapidly progressive fistula operate whether cough exists or not; if much cough exists, do not operate unless the fistula is rapidly progressive; in the last stages of phthisis do not operate.

Pruritus of the anus is a symptom, and not a disease. It may be due to piles, fissure, seat-worms, eczema, nerve-disturbance, kidney disease, jaundice, constipation, inebriety, the opium-habit, torpid liver, dyspepsia, alcohol, tea-drinking, vesical calculus, tobacco-smoking, urethral stricture, uterine disease, diabetes, ovarian trouble, and mental disorder. The itching is worse at night, and is often of fearful intensity.

Treatment.—Remove the cause. Prevent constipation.

Several times a day wash the parts with very hot water, dry them, and apply a mixture containing ʒj of campho-phenique and ℥j of water (Mathews). Kelsey directs that the parts be cleansed twice a day, and after each cleansing that the following ointment be applied: menthol, ʒj; cerat. simp., ℥ij; oil of sweet almonds, f℥j; acid. carbolic., ʒj; pulvis zinc. oxid., ℥ij. Mathews commends the following mixture: chloral, ʒj; gum-camphor, ʒss; glycerin and water, each ℥j.[1] In this disease a "scarf-skin" forms, which must be made to peel off by the application of iodin, pure carbolic acid, corrosive sublimate (grs. iv to ℥j of cosmolin), calomel (ʒij to ℥j of cosmolin), or campho-phenique. In obstinate cases paint the parts, night and morning, with a mixture of 60 gr. of alum, 30 gr. of calomel, and 300 gr. of glycerin; or smear with an ointment composed of $\frac{1}{2}$ part of oleate of cocain, 3 parts of lanolin, 2 parts of vaselin, and 2 parts of olive oil (Morain). In very severe cases touch with a solution of silver nitrate (1 : 10), employ the Paquelin cautery, or resect the mucous membrane as in Whitehead's operation for hemorrhoids.

Fissure of the anus is an irritable ulcer at the anal orifice producing spasm of the sphincter. Pain exists because twigs of nerves are exposed upon the floor of the ulcer. Fissure is caused by constipation or traumatism. The **symptom** is violent, burning pain, sometimes beginning during defeçation, but usually at the end of the act, and lasting for some hours. Constipation exists, and often pruritus. Examination discloses a fissure, usually at the posterior margin, running up the bowel one-quarter to one-half an inch. Piles often exist with fissure.

Treatment.—The *palliative treatment* is to prevent constipation, to wash out the rectum with cold water, and apply an ointment made by evaporating ℥ij of the juice of conium to ʒij, and adding it to ℥j of lanolin and gr. xij of persulphate of iron. Pure ichthyol may do good. In *operative treatment* stretch the sphincter. In order to stretch the sphincter the patient is anesthetized, the surgeon's thumbs are inserted into the rectum, and the parts are stretched until the thumbs touch the ischia. After stretching the sphincter incise the floor of the fissure, scrape it with a curet, and touch with nitrate of silver stick.

[1] *Diseases of the Rectum.*

XXIX. ANESTHESIA AND ANESTHETICS.

Anesthesia is a condition of insensibility or loss of feeling artificially produced. An **anesthetic** is an agent which produces insensibility or loss of feeling. Anesthetics are divided into—(1) *General anesthetics*, as amylene, chloroform, ethylene chlorid, ether, bromid of ethyl, nitrous oxid, and bichlorid of methylene; (2) *Local anesthetics*, as alcohol, bisulphid of carbon, chlorid of ethyl, carbolic acid, ether spray, cocain, eucain, ice and salt, rhigolene spray, and ethyl chlorid spray.

Anesthesia may be induced by a general anesthetic to abolish the usual pain of labor and of surgical procedures; to produce muscular relaxation in tetanus, herniæ, dislocations, and fractures; and to aid in diagnosticating abdominal tumors, joint-diseases, fractures, and malingering.

Whenever possible, *prepare* a patient for anesthesia, and prepare him, if the case admits of it, during two or more days. Heart disease is not a positive contraindication to surgical anesthesia. It is quite true that anesthetics are dangerous in people with fatty hearts, but shock is also dangerous, and the surgeon stands between the Scylla of anesthesia and the Charybdis of shock. Gallant truly says that not enough attention is paid to the "character of the pulse and action of the heart before operation, by which to compare its work during anesthesia, and after the operation is over, and this neglect leads to unnecessary stimulation and overdriving a heart which is doing its average best."[1] Always examine the urine if the nature of the case allows time. If albumin is found, operation is not contraindicated; but the peril of anesthesia is greater, and certain dangers are to be watched for and guarded against. If much albumin is present, postpone operation except in emergency cases. If much sugar is found, the danger is considerable, as diabetic coma occasionally develops. Empty the intestinal canal by purgation. It is well to give the bowel six to twelve hours' rest before operation. The usual custom is to give a saline cathartic the evening before operation and an enema early on the morning of the operation. Of course, frequently the nature of the case or the necessity for haste does not permit of preliminary emptying of the intestine by the administration of cathartics. During the twenty-four hours preceding operation the food should be easily digestible and given in small amounts. During the day or so before operation there is usually

[1] *Medical Record*, February 2, 1899.

impaired digestion, and no undue strain should be put upon the stomach. In the morning allow no breakfast if the operation is to be performed at an early hour; but if the patient is very weak, order a little brandy and beef-tea. If the operation is to be about noon, give a breakfast of beef-tea and toast or a little consommé; *never* give any food within three hours of the operation, but brandy is admissible if it is required. If the stomach is not empty at the time of operation, vomiting is almost inevitable, and portions of food may enter the windpipe; if the stomach contains no food, vomiting is far less likely to happen, and even if it occurs and vomited matter should enter the windpipe, it may do little harm, as it consists chiefly of liquid mucus. In cases of intestinal obstruction in which there has been stercoraceous vomiting there is much danger that vomiting will occur during anesthetization. In some cases of intestinal obstruction, during the administration of the anesthetic, and during the anesthetic state, a stream of stinking brown fluid may flow without effort from the mouth. Vomiting or regurgitation of stercoraceous material is profuse, sudden, and dangerous. It may flood the bronchial tubes during inspiration and cause death by suffocation. In such a case wash out the stomach before giving the ether. If a patient with intestinal obstruction is too weak to permit lavage, use only local anesthesia. Vomiting while under an anesthetic is dangerous in any case, because of the great cardiac weakness which precedes and follows it. If a patient sleeps well the night before an operation, he will probably take the anesthetic better than if he sleeps poorly. Effort should be made to obtain a night's sleep. An excellent expedient is a hot ammonia bath, followed by a rub-down with weak alcohol.[1] It may be necessary to administer trional or bromid. Before giving the anesthetic see that artificial teeth are removed and that the patient does not have a piece of candy or a chew of tobacco in the mouth. Always have a third party present as a witness, because in an anesthetic sleep vivid dreams often occur, and erotic dreams in women may lead to damaging accusations against the surgeon. Place the patient recumbent. The effort should be to place him in as comfortable a position as possible if this position is consistent with operative necessities. See that the clothing is loose, particularly that there is no constriction about the neck and abdomen. Do not have the head high unless this position is demanded by the exigencies of the operation. The

[1] A. Ernest Gallant, *Med. Record*, December 30, 1899.

anesthetist must have a mouth-gag, a pair oı tongue-forceps, a hypodermatic needle in *working* order, and solutions of strychnin, atropin, digitalis, and brandy. It is well to have an electric battery and a can of oxygen at hand. Accidents, it is true, are rare, but they may happen at any time, and hence the surgeon should always be prepared for them. Any danger which arises must be met with promptness and decision, or action will be of no avail. Many surgeons give a hypodermatic injection of morphin a short time before operation, to steady the heart, prevent vomiting during anesthetization, to shorten the stage of excitement, and aid the bringing about of insensibility with very little of the anesthetic. There are, however, objections to morphin before anesthesia, and its use should be the exception and not the rule. It depresses the respiration, lowers temperature, and thus increases operative shock, interferes with the pupillary phenomena of anesthesia, delays awakening from the anesthetic sleep, and actually favors post-anesthetic vomiting. In some cases we may anticipate trouble from the anesthetic. Cyanosis may occur in drunkards; in fat, thick-necked individuals of the Major Bagstock type, who are short of breath and congested in appearance; in individuals with some disease of the lungs, bronchi, pharynx, larynx, or trachea (empyema, emphysema, chronic bronchitis, croup, cancer of the larynx, etc.); in individuals suffering from fatty heart or valvular incompetence. Buxton points out that an individual without teeth and with stenosis of the nares is apt to become cyanotic under an anesthetic, because the lips and pillars of the fauces are drawn in like valves during inspiration.

The two favorite anesthetics are ether and chloroform. Chloroform is more dangerous than ether in general cases, though it is more agreeable, less irritant to the lungs and kidneys, and quicker in its action. Chloroform is a safer anesthetic in warm than in cold countries. Recovery from chloroform is quicker and quieter than that from ether, but chloroform-vomiting lasts longer than ether-vomiting. Chloroform may induce sudden and even fatal syncope. Hare's experiments on animals indicate that chloroform may kill by respiratory failure occurring secondarily to failure of the vasomotor center; but certain it is that clinically the danger of chloroform is paralysis of the heart, and this condition may come on so rapidly that death may occur almost before an attempt can be made to save life. Leonard Hill has proved that most chloroform-deaths that take place after considerable of the anesthetic has been taken arise from para-

lytic distention of the heart. Sudden death, when inhalations of chloroform have just commenced, may be due to the irritant vapor acting on the nasal mucous membrane, exciting a nasal reflex and powerfully stimulating cardiac inhibition. If ether kills, it does so usually through the respiration, and not the heart, and there is generally time to undertake means of resuscitation, which means are apt to be successful. Chloroform is to be preferred to ether in the following cases: for children under ten years of age, in whom ether causes a great outflow of bronchial mucus, which may asphyxiate; for people over sixty, free from advanced cardiac disease, at which age most persons have some bronchitis, and ether chokes them up with mucus. Ether also irritates the kidneys, which at the latter age are apt to be weak or diseased. Chloroform is preferred for labor cases, when moderate anesthesia only is required, and for operations on the mouth and nose. In cleft-palate operations chloroform is usually preferred, because it causes but little cough and salivary flow. In ligation of a large artery which is overlaid by a vein, ether exercises the unfortunate influence of greatly enlarging the vein. Hence in such a case chloroform makes the operation easier. In goiter operations ether should not be used, as it enlarges enormously the veins. Chloroform is preferred for patients with difficult respiration from any cause other than heart disease, for patients with kidney disease, and for patients with diabetes. Some surgeons do not use ether in abdominal operations, because they believe it may cause persistent oozing of blood, but this view is not in accord with the author's experience. Ether is safer in patients with heart disease, and is the best and safest anesthetic for general use. Both ether and chloroform may induce changes in the blood.[1] In practically all cases they produce a diminution of hemoglobin and leucocytosis. In some cases they produce alteration in the shape of the corpuscles. These changes are especially marked in anemic blood. Ether produces distinct leucocytosis, probably toxic in origin. These blood-changes indicate that prolonged anesthesia may militate against recovery from a severe operation. If a patient's hemoglobin is below 30 per cent., a general anesthetic should not be given. During the state of anesthesia the temperature drops from one to three degrees, hence the patient should be carefully covered during the operation. The question as to the effect of ether on the kidneys is much disputed.

[1] See the author on the "Blood-alterations of Ether-anesthesia," *Medical News*, March 2, 1895.

Most surgeons believe that it tends to cause albuminuria or increase existing albuminuria. In giving ether or chloroform the administrator must devote his undivided attention to the task. He must note every symptom, must order or carry out proper treatment for complications, and must keep the operator informed as to the necessity for haste. The anesthetist must be a man who has a wholesome respect for ether and chloroform, although not afraid of them.

Administration of Chloroform.—In administering chloroform have at hand a mouth-gag, tongue-forceps, a clean towel, a hypodermatic syringe, solutions of strychnin, atropin, and brandy, an electric battery, and a can of oxygen. Use only *pure* chloroform (Squibb's). The patient must be recumbent. No special inhaler is required, but the drug may be given upon a thin towel, a napkin, or a piece of lint. The inhaler of Esmarch is very useful. In operations about the face Souchon's instrument is serviceable. Souchon's apparatus is so arranged that choloform may be given through a tube which is introduced through the nose, the instrument being well out of the way of the operator. Some surgeons cocainize the nares before giving chloroform, so as to prevent the dangerous nasal reflex (Rosenberg). The chloroform-vapor must be well mixed with air. The chloroform is sprinkled on the fabric with a drop-bottle. Raise the napkin well above the mouth, add five drops of chloroform, and tell the patient to take deep and regular breaths. Add a few more drops of chloroform, and when the patient grows so accustomed to it as not to choke, turn the wet part of the fabric toward the face and place it near the mouth; do not touch the mouth with the wet lint, because it will blister. It is a good plan to smear the lips with cosmolin to prevent blistering. If the drug is given *gradually*, struggling is not usually violent or prolonged. Never pour on a large amount at one time. During the stage of excitement do not suspend the administration of chloroform unless respiration becomes difficult, in which case suspend it until the patient takes one or two respirations. If the patient struggles, do not push the drug. He holds his breath while struggling, and as struggling ceases takes full, deep breaths. If the inhaler is saturated with chloroform, he may inhale a dangerous amount during the deep respiration after struggling. Chloroform given in considerable amount when the patient is breathing deeply from ether is unsafe. If chloroform is given subsequent to anesthetization by ether, it should be given gradually and well mixed with air. When the patient becomes anes-

thetized give just enough of the drug to keep him so. Stop the administration or give very little when shock becomes evident or when there is profuse hemorrhage. Chloroform-vapor is not inflammable, hence it is safer than ether when a hot iron is to be used about the face and when there is a lighted lamp or a stove in a small room; but the presence of flame decomposes chloroform into irritant products of chlorin, which sometimes cause the patient and the surgeon to cough. A combination of chloroform and oxygen is used by some administrators. The patient who is anesthetized with the mixed vapor retains a good color, but it requires a considerable time to render him unconscious.

Administration of Ether.—Ether is best given by means of an Allis inhaler (Fig. 340). Have at hand the same drugs and appliances as when chloroform is given. Place the dry inhaler over the mouth and nose, let the patient take several breaths to gain confidence, pour a few drops of ether into the cone, let the patient take several more breaths, and so on, gradually increasing the amount of ether. Never suddenly add a large amount of the anesthetic: it causes coughing and often vomiting. When the patient becomes thoroughly anesthetized, diminish the amount of ether. When bleeding is profuse or shock is marked, suspend the administration of ether or give very little of it. If a hot iron is to be used about the face, remove the cone and fan away the ether before bringing the iron near. Have any light set high up, as ether-vapor is heavier than air, and no explosion is possible until it reaches the level of the flame. If the vapor takes fire, cover the patient's mouth and nose with a towel. The use of oxygen with ether delays the production of unconsciousness.

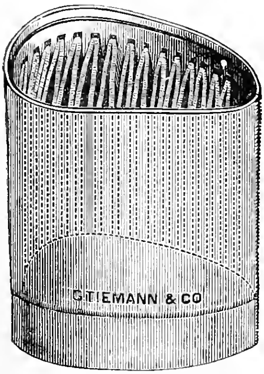


Fig. 340.—Allis's ether-inhaler.

Anesthetic State from Ether or Chloroform.—The inhalation of an anesthetic produces irritation of the fauces, often some cough, a profuse secretion of mucus, acts of swallowing, dilatation of the pupils, flushed face, and sometimes struggling (especially in children and in drunkards). If the vapor is given at once in concentrated form, cough will be violent and will cause cyanosis. If the anesthetic is given carefully, the cough soon ceases, the respirations become

rapid and often convulsive, the pulse becomes frequent, and the patient passes into a condition of active intoxication with preservation of sight and touch, loss of hearing and smell, diminution of pain and sensibility, and often with illusions or hallucinations. In this stage the patient may struggle, and while efforts are being made to hold him cyanosis may occur. From the stage of excitement just alluded to, many subjects (strong men and drunkards) pass into a stage of rigidity in which the muscles become rigidly fixed, the breathing impeded, the respirations stertorous, and the face bluish and congested. Too rapid forcing of the anesthetic tends to cause rigidity, and a skilled anesthetist endeavors to avoid its production, because it is dangerous. The next stage is one of insensibility: the pupils are contracted, but react to light. If anesthesia is deep, the contracted pupils will not react to light; if anesthesia is profound, the pupils dilate, but will not react to light. The conjunctival reflex is gone; the lids are closed; if the arm is lifted and allowed to fall, it drops as a dead weight; the skin is cool and moist, and often wet with sweat; the respirations are easy and shallow; the pulse is slow; and there is complete unconsciousness to pain. The loss of the conjunctival reflex is the usually accepted sign that the patient is unconscious. In a young child this reflex is soon exhausted by touching the eye, and the sign is unreliable. If a baby is to be anesthetized, the administrator places his finger in the infant's hand. The child grasps the finger, and relaxes its grasp when unconscious.

Always bear in mind that a dilated pupil reacting to light and associated with preserved conjunctival reflex means that anesthesia is not complete; that a contracted pupil reacting to light and without conjunctival reflex means moderate anesthesia; that a contracted pupil not reacting to light and without conjunctival reflex means deep anesthesia; that a dilated pupil not reacting to light and associated with lost conjunctival reflex means dangerously profound anesthesia; that weak pulse and pallor may be due to nausea, but always require instant attention; that vomiting may be due to forcing strong vapor upon the patient, but that it may also be due to his partially emerging from a state of insensibility.

Watch the pulse carefully to see if it becomes very weak, irregular, abnormally slow, or abnormally fast. Syncope may be due to nausea, shock, hemorrhage, or the giving of too much of the drug. Watch the respiration, and do not forget that the chest-walls and belly may move when no air is entering the lungs; hence always *listen* to the breathing.

Cyanosis is a dusky or bluish discoloration of the skin. This condition indicates want of oxygen in the blood. The individual may have been cyanotic or predisposed to cyanosis to start with; cyanosis may be due to posture; to cough early in the administration; to struggling during the stage of excitement or to rigid fixation of the respiratory muscles. It may also be due to obstruction of the air-passages by some foreign matter, as blood or vomit, lodging in the bronchial tubes, windpipe, larynx, or pharynx; falling back of the tongue (swallowing of the tongue); closure of the epiglottis; or to the glottis being pushed against the pharyngeal wall by bending the head forward. Some patients with occluded nostrils may fail to get enough air because of closure of the lips. A patient may appear to "forget to breathe." Shock is manifested by deadly pallor, weak and irregular pulse, slow respiration, cold extremities, and a drenching sweat. In rare cases edema of the lungs occurs.

Treatment of Complications.—*Vomiting* due to too much anesthetic is corrected by giving a few breaths of air; vomiting due to incomplete anesthesia is amended by giving more of the vapor. When the patient vomits, hang the head over the edge of the bed, separate the jaws with the gag, and wipe out the vomited matter, mucus, and saliva. *Shock* is treated by diminishing the amount of the anesthetic given, by the hypodermatic injection of brandy, strychnin, or atropin (the last-named drug is very useful when there is a profuse sweat), by the administration of hot saline fluid by the rectum, by surrounding the patient with hot-water bottles, or by wrapping him in hot blankets, and by lowering the head of the bed. A tendency to *syncope* requires lowering of the head of the bed, suspension of the anesthetic, and hypodermatic injection of strychnin. In *extreme syncope*, which is most apt to occur from chloroform, do not wait for breathing to cease, but suspend the anesthetic, lower the head of the bed, open the mouth with the gag, catch the tongue and make rhythmical traction while an assistant is making *slow* artificial respiration. If the patient does not *at once* improve, invert him completely, holding him by the legs and continuing artificial respiration by compressing the sternum (Nélaton). By continuing artificial respiration the blood is urged on through the heart. Leonard Hill holds that in the failure which arises soon after administration of chloroform is begun the trouble is due to vasomotor paralysis with starvation of the nerve-centers. In such a case he applies abdominal compression and inverts the

patient, making artificial respiration at the same time. In the failure which occurs after considerable chloroform has been taken there are paralytic distention of the heart, fulness of the venous system, and loss of the compensations for the hydrostatic effects of gravity. In such a condition empty the distended heart of venous blood by raising the patient into an erect position; and after a moment place him recumbent and make artificial respiration. Give hypodermatic injections of ether, brandy, strychnin, or even of ammonia. Put mustard over the heart and spine. Employ faradism to the phrenic nerve (one pole to the epigastric region, the other to the right side of the root of the neck). Let fresh air into the room, put hot water-bottles around the legs, apply friction to the extremities, wrap the patient in hot blankets, give an enema of brandy, and hold ammonia or nitrite of amyl to the nose.

"Forgetting to breathe" is met by removing the inhaler and waiting a moment; a breath will usually be taken soon; but if it is not taken, open the mouth and pull forward the tongue; this causes a reflex inspiration. Cyanosis is practically not encountered when oxygen is given with ether or chloroform. *Cyanosis*, if slight, and due to cough or struggling, is met by removing the inhaler while the patient takes a breath or two of air. If position is responsible for cyanosis, correct it. In empyema, lying upon the sound side may produce it, and obstruction to breathing may be due to bending down the head. If due to stenosis of the nares in a person without teeth, hold the lips apart with a finger.

Dudley W. Buxton points out that duskiness will often pass away if ether is removed, one or two inhalations of chloroform given, and ether then continued. If in any case cyanosis is severe or grows worse, suspend the drug, dash cold water in the face, force open the jaws, pull forward the tongue, make artificial respiration until a breath is taken, and then give oxygen for a time. If these means fail, stretch the sphincter ani and bleed from the external jugular vein. If a breath is not now taken, do tracheotomy. In respiratory or heart failure forced artificial respiration by Fell's method is of great value. In Fell's method a tracheal tube is inserted, and by means of a foot-bellows air is forced into the lungs, after first passing through a warming chamber. Instead of a tracheal tube, we may use a face-mask and an intubation-tube. "Swallowing the tongue" is corrected by pulling the tongue forward. If it tends to recur, lay the head upon its side or keep the tongue anchored with forceps. *Closure of the*

epiglottis is corrected by pulling the patient's head over the edge of the table and pushing strongly back upon his forehead. This maneuver lifts the hyoid bone, and with it the epiglottis. The epiglottis can be lifted by passing a spoon-handle or the index-finger over the dorsum to the base of the tongue and pressing forward. If, in obstruction to respiration, the above means fail, make artificial respiration at once; if obstruction continues, perform tracheotomy.

Edema of the lungs is treated by instant venesection, the inhalation of nitrite of amyl, and the administration of stimulants and nitroglycerin hypodermatically.

Artificial Respiration.—**Laborde's Method.**—Place the patient on his back with the head lower than the body, all the clothing loosened, and the jaws wedged apart, and wipe the mucus from the throat and mouth. Grasp the tongue with forceps, and once in every four seconds pull it quickly and strongly forward and then permit it to go back. It may be necessary to keep up this proceeding for thirty minutes or even more.

Laborde's method should be associated with "concentric thoracic and upward abdominal pressure applied in a rhythmic manner by two assistants at the time of relaxation of the tongue."[1] Laborde believes that tongue-traction causes contractions of the diaphragm.

Sylvester's Method (Figs. 341, 342).—The patient is placed recumbent with the foot of the bed raised. The surgeon grasps the arms just above the elbows, and draws them outward and upward until they are nearly perpendicular; they are held perpendicular for two seconds while air is entering the lungs; the arms are then lowered and pressed against the sides of the chest for two seconds, during which time the chest is emptied as in expiration. These movements of elevation and depression are made twelve or fifteen times a minute.

The Reaction from Anesthesia.—After the administration of the anesthetic has been suspended and the operation has been completed the temperature is usually subnormal. The patient must be watched until consciousness returns If he is left alone, a change of posture may lead to arrest of the feeble respiration, the assumption of the erect position may cause fatal syncope, or mucus or vomited matter may block the air-passages and cause suffocation. The best position to place him in is the recumbent, the head being level with the body or somewhat lower, and the side of

[1] Joseph D. Bryant's *Operative Surgery*.

the face resting on the pillow. Shock is treated by ordinary methods. The inhalation of oxygen is of great value in rousing a patient from the state of anesthesia, and will often prevent vomiting. If vomiting occurs, the head should be upon its side or should be hung over the edge of the bed, and after the spell of vomiting the mouth must be wiped clear. The face should be washed with cold water and be fanned rather actively. It is routine practice in the Jefferson

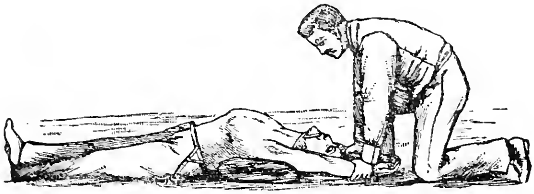


FIG. 341.—Artificial respiration, first movement.

Medical College Hospital to administer vinegar by inhalation during the reaction from an anesthetic. This proceeding often prevents vomiting. Some patients awake as from a quiet sleep; others are noisy, turbulent, and violent. The duration of the period of reaction varies with the anesthetic used, the amount given, and the personal tendencies of the

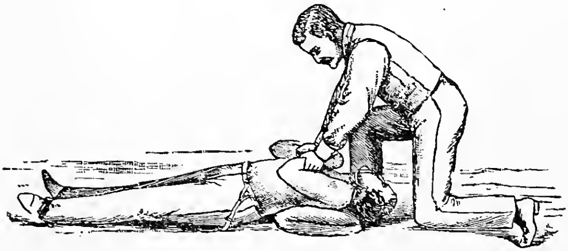


FIG. 342.—Artificial respiration, second movement.

patient. The patient must not be allowed to sit up for several hours at least. No food is to be allowed for four hours.

After-effects of Anesthetics.—Vomiting.—Vomiting may persist for hours, greatly exhausting the patient and doing infinite harm, it may be, if the operation were upon the brain or an intra-abdominal structure. If vomiting continues, forbid food. Very hot water in doses of a teaspoonful should be given at frequent intervals. A draught of hot water may relieve the condition by washing out the mucus from the

stomach. Other remedies which may succeed are: hot black coffee, a mustard plaster over the stomach, fresh air in the room, small pieces of ice placed in the mouth and sucked, small doses of iced champagne, and drop doses of a 3 per cent. solution of cocain or 3-drop doses of a 5 per cent. solution of eucain. The best remedies for persistent vomiting are inhalation of vinegar and lavage of the stomach. Some persons, as Dudley W. Buxton points out, suffer greatly from nausea although there is little or no vomiting. In such cases Buxton uses ♏j of tincture of nux vomica in a teaspoonful of hot water every ten minutes until six doses are taken. If this plan fails, he gives drop doses of wine of ipecac or minim doses of dilute hydrocyanic acid.[1]

Vomiting from chloroform is usually more difficult to check than vomiting from ether.

Respiratory disorders are more often noted after ether than after chloroform. Bronchitis may follow or bronchopneumonia (ether-pneumonia). Respiratory difficulties may be due to chilling the patient by bringing him from a warm operating-room through a cold hall and into a cool bedroom. Bronchopneumonia is especially common in septic patients, and may be due in some cases to aspiration of septic material into the bronchi (cases of cancer of tongue and pharynx, and cases with stercoraceous vomiting). Bronchitis and bronchopneumonia are much more common after ether than after chloroform. They are treated by ordinary methods. If chloroform is given when a gas-light is in the room, the vapor is decomposed and certain highly irritant products are inhaled, which produce laryngeal spasm and possibly bronchitis. The treatment is to freely admit fresh air into the room, and to have the patient inhale oxygen or vinegar. Ether-pneumonia must not be confounded with post-operative bronchopneumonia, described by Wm. H. Bennett.[2] This latter condition, according to Bennett, may arise from seven to fourteen days after operation in robust, gouty people, and is usually unilateral

Renal Complications.—After the administration of an anesthetic, blood, albumin, or sugar may appear in the urine, and the secretion may become scanty or even be suppressed. It is usually maintained that chloroform is less apt to irritate the kidneys than is ether, but there has been much dispute on this point. If albumin is present before anesthetization, the condition may be rendered worse when ether or chloroform is given. The truth of the matter probably is that if

[1] *Anesthetics*, by Dudley W. Buxton. [2] *Practitioner*, Dec., 1896.

the kidneys are healthy a small or moderate amount of either drug is not particularly irritant; but if the kidneys are diseased, a small amount, and even if they are healthy, a large amount, of either drug produces decided renal irritation. Chloroform is said to be less irritant only because less chloroform than ether is given to secure and maintain anesthesia. Scantiness or suppression of urine may be due to shock rather than to ether or chloroform. If the urine becomes somewhat scanty or if albumin appears in it, give non-irritant diuretics, diaphoretics, and cathartics, and employ enteroclysis. If the urine becomes very scanty, use hypodermoclysis. If post-operative suppression arises, give intravenous infusion of hot saline fluid.

Post-anesthetic Paralysis.—Paralysis may arise during anesthesia as a result of cerebral hemorrhage or embolism.

It sometimes happens that when a person has come out of anesthesia a palsy of some part is found to exist, the condition being peripheral and not central in origin. Such palsies may be due to pressure of an extremity upon a table-edge or to pressure upon nerves by placing the patient in certain positions.[1] Garrigues points out that when the arm is elevated to the side of the head or when it is drawn out strongly from the body the brachial plexus may be compressed by the head of the humerus (Braun). When the arm is in external rotation and is drawn backward and outward the median nerve is stretched, and when the forearm is flexed and supinated the ulnar nerve is stretched (Braun, quoted by Garrigues). Garrigues insists that in most cases the brachial plexus is squeezed between the collar-bone and first rib, and it is particularly apt to be squeezed when it is stretched by the head being drawn to the opposite side or being allowed to fall back.[2]

Post-anesthetic paralysis is most common in the arm, but may occur in the leg or face. The prognosis is good as a rule. The treatment is that of any pressure-palsy.

Primary Anesthesia.—Instruct the patient to count aloud and hold one arm above his head. Give the ether rapidly. In a short time he becomes mixed in his count and his arm sways or drops to the side. There is now a period of insensibility to pain lasting only about half a minute, and during this period a minor operation can be performed. The patient quickly reacts from primary anesthesia without vomiting (Packard).

[1] H. J. Garrigues, in *Amer. Journ. Med. Sciences*, Jan., 1897.
[2] *Amer. Journ. Med. Sciences*, Jan., 1897.

A. C. E. Mixture.—This mixture is often valuable in cases in which ether cannot be given. It is composed of 1 part of alcohol, 2 parts of chloroform, and 3 parts of ether. Its action is supposed to be between that of chloroform and ether. The objection to the A. C. E. mixture, as to any mixture, is that the materials do not evaporate in the ratio in which they are mixed, hence an uncertain amount of chloroform vapor is being inhaled (Buxton). This mixture can be given in a Junker or an Allis inhaler. Plenty of air must be given with it. The anesthetic acts similarly to chloroform.

Ethyl bromid is sometimes used for short operations. The unconsciousness is obtained in one-half minute and is rapidly recovered from, and there is no after-sickness. The unconsciousness lasts about three minutes. Three drachms are given to a child, and six drachms to an adult. A towel is put over the face, and the entire amount to be given is poured on at once, and as soon as the patient is unconscious the towel is taken away and no more of the drug is given (Cumston). Cases have been reported in which sudden death has followed the administration of this drug, and it should not be given if there is disease of the heart, lungs, or kidneys.[1]

Schleich has recently introduced **a new anesthetic agent** which he claims is safer than chloroform. This surgeon maintains that a material is safe as an anesthetic only when almost all of the amount taken in at an inspiration is expelled on expiration. The anesthetic is unsafe in direct proportion to the amount absorbed; and the lower the boiling-point of an anesthetic the less is absorbed; hence an anesthetic agent, to be safe, should have a low boiling-point. Schleich makes three solutions. The first contains (by volume) 1½ oz. of chloroform, ½ oz. of petroleum ether, and 6 oz. of sulphuric ether. The second contains 1½ oz. of chloroform, ½ oz. of petroleum ether, and 5 oz. of sulphuric ether. The third contains 1 oz. of chloroform, ½ oz. of petroleum ether, and 2⅔ oz. of sulphuric ether. The anesthetic can be given on an Esmarch inhaler, an Allis inhaler, or a towel. The anesthetic state is quiet, reaction is rapid, and vomiting occurs in but half the cases. The superiority of this new anesthetic has not been proved. It sometimes causes dangerous symptoms, and has produced death. Garrigues, who formerly approved of it, has abandoned it. It will certainly not displace ether or chloroform.

[1] See Cumston, in *Boston Med. and Surg. Journ.*, Dec. 20, 1894.

Nitrous-oxid gas may be used to obtain anesthesia for brief operations. This gas is stored in steel cylinders, in which it is liquefied. The gas is passed into a rubber bag, and is given to the patient by means of a tube and a mouth-mask, a wedge being placed between the patient's molar teeth, and the nostrils being closed by the anesthetist's fingers. The wedge must be held by a string, so that it cannot be swallowed. The patient becomes unconscious in about one minute, and we know the patient is anesthetized by the stertor and cyanosis and the insensitiveness of the conjunctivæ. Watch the pulse, and if it flags at once suspend the administration. The phenomena are asphyxial (stertorous respiration, cyanosis, and even convulsions, dilatation of the pupils, rapidity of the heart, and swelling of the tongue).[1] It is sometimes useful to give nitrous oxid first and follow this with ether. If this method is employed a small amount of nitrous oxid is given, and the ether is gradually added. It is dangerous to give a full dose of nitrous oxid and then suddenly give a quantity of ether (Hewitt). For children and women the method is of great service, but it should not be used for muscular men or stout men of middle age or over.[2] By this method the patient is anesthetized rapidly and pleasantly with the nitrous oxid, and the anesthesia is maintained by the ether.

It used to be thought that nitrous oxid necessarily produces cyanosis, because the gas can only cause anesthesia by partially asphyxiating the patient. We know this is untrue, because if nitrous oxid is mixed with oxygen or atmospheric air anesthesia is obtained without cyanosis. Nitrous oxid is a genuine anesthetic agent. If a prolonged administration of nitrous oxid is desired, pure nitrous oxid can be given, a breath of fresh air being allowed from time to time. By this method Preston has anesthetized many patients, the duration of the anesthesia being from ten to fifty minutes. A better plan is to give nitrous oxid and oxygen. Hewitt formulates the following views as to the use of oxygen and nitrous oxid:[3]

"In order to obtain the best form of anesthesia oxygen should be administered with nitrous oxid by means of a regulating apparatus, the percentage of the former gas being progressively increased from 2 or 3 per cent. at the commencement of the administration to 7, 8, 9, or 10 per cent.

[1] See Hewitt, *Brit. Med. Journ.*, Feb. 18, 1899.
[2] Hewitt, in *Lancet*, Feb. 19, 1898.
[3] *Brit. Med. Journ.*, Feb. 18, 1899.

according to the circumstances of the case. The longer the administration lasts the greater may be the percentage of oxygen admitted.

"The next best results to those obtainable by means of a regulating apparatus for nitrous oxid and oxygen are to be secured by administering certain constant mixtures of these two gases. Mixtures containing 5, 6, or 7 per cent. of oxygen are best for adult males; and mixtures containing 7, 8, or 9 per cent. are best for females and children. The next best results to those last mentioned are to be obtained by means of mixtures of nitrous oxid and air, from 14 to 18 per cent. of the latter being advisable in anesthetizing men, and from 18 to 22 per cent. in anesthetizing women and children."

Local Anesthesia.—Freezing with Ice and Salt.—Take one-quarter of a pound of ice, wrap it in a towel, and break it into fine bits; add one-eighth of a pound of salt; then place the mixture in a gauze bag and lay it upon the part. The surface becomes pallid and numb, and in about fifteen minutes decidedly analgesic. A *spray of rhigolene* freezes a part in about ten seconds. It is highly inflammable. *Ether-spray* anesthesia was suggested by Benjamin Ward Richardson. *Chlorid of ethyl* comes in glass tubes. Remove the cap from the tip of the tube and hold the bulb in the palm: the warmth of the hand causes the fluid to spray out. Hold the tube some little distance from the part and let the fine spray strike the surface. The skin blanches and whitens, and is ready for the operation in about thirty seconds.

Cocain Hydrochlorate.—Always bear in mind that cocain is sometimes a decidedly dangerous agent. There are on record fourteen deaths from cocain (Reclus). The urethra is a particularly dangerous region, and so is the face. Never use over two-thirds of a grain upon a mucous surface, and never inject hypodermatically more than one-third of a grain, and be sure never to inject the drug into a vein. Mild cases of cocain-poisoning are characterized by great tremor, restlessness, pallor, dry mouth, talkativeness, and weak pulse. In severe cases there is syncope or delirium. Death may arise from paralysis or from fixation of the respiratory muscles (Mosso). Cases with a tendency to respiratory failure require the hypodermatic injection of strychnin. In cases with tetanic rigidity of muscles give enemata of chloral, hypodermatic injections of nitroglycerin, or inhalations of the nitrite of amyl. In cases marked by delirium, if the circulation is good, give chloral

or hyoscin. In any case give stimulants, employ a catheter, and favor diuresis. Cocain-poisoning is always followed by a wakeful night. Cocain should not be used if the kidneys are inefficient. In using cocain try to prevent poisoning. Because of the dangers inherent in cocain, have the patient recumbent. One minute before giving the cocain administer one drop of a 1 per cent. alcoholic solution of trinitrin, repeating the dose once or twice during the operation. In operating on a finger, after making the part anemic, tie a tube around the root of the digit before injecting cocain, and after the operation gradually loosen the tube. A hot solution of cocain is more efficient than a cold solution (T. Costa); hence hot solutions can be used in much less strength and are safer. The method of injection is as follows: A sharp needle is held at an angle of forty-five degrees to the surface, and is pushed into the Malpighian layer. One or two minims of a 2 per cent. solution are forced into the Malpighian layer, and a whitened elevation forms. The needle is withdrawn, at the margin of the wheal is reinserted, and more fluid is introduced, and so on until the region to be operated upon has been injected. After waiting five minutes the operation is begun. If, after cutting the skin, it is necessary to cut the subcutaneous tissue, pour a few drops of a 1 per cent. solution into the wound from time to time. After the completion of the operation, if a rubber band were used, it is loosened for a few seconds, tightened for a few minutes, again loosened and readjusted, and so on several times (Wyeth). In this way only a small quantity of cocain is admitted into the circulation at one time, and toxic symptoms are thus prevented. For operations upon the eye a 1 to 4 per cent. solution is instilled; a drop of fluid is instilled every ten minutes until three drops have been given. Over $\frac{2}{3}$ of a grain should not be painted upon a mucous membrane. Rarely use over a 10 per cent. solution on mucous membranes, although in laryngeal operations a 20 per cent. solution may be required. For the nasal mucous membrane a bit of wool soaked in a 5 per cent. solution is inserted or a spray of 4 per cent. solution is thrown from an atomizer into the nostrils. In the rectum, vulva, vagina, and uterus use a 5 per cent. solution; in the urethra a 4 per cent. solution, and in the bladder a 2 per cent. solution.

Cocainization of a Nerve-trunk.—Krogius has pointed out that if cocain is injected into the tissue about a nerve-trunk anesthesia will follow in the area supplied by the

nerve. The anesthesia will be produced in five minutes, and will last fifteen minutes. If cocain is injected about the root of the finger, all of the tissues of the digit will become insensitive. Injection over both supraorbital notches renders the middle of the forehead insensitive. Injection over the ulnar nerve causes complete anesthesia of its trajectory. This plan is extensively used in Helsingfors.

Eucain hydrochlorate is far safer than cocain, and in most cases is to be preferred to it. Eucain is employed. It is injected in the strength of from 2 to 5 per cent. It can be boiled without destroying its properties, and hence can be readily rendered sterile. It occasionally, though rarely, happens that the injection of eucain causes sloughing, especially at the extremities, in fatty tissue, in tendon-sheaths, and in bursæ. It can be used on mucous membranes.

Infiltration-anesthesia was devised by Schleich of Leipsic, who was dissatisfied with cocain, because it is not safe and sometimes fails to produce satisfactory anesthesia, owing to want of thorough diffusion. He found that salt solution (0.2 per cent.), if injected into uninflamed parts, produced anesthesia. To obtain this anesthesia the part must be distended by wide infiltration. If minute quantities of cocain, morphin, and carbolic acid are added to the solution, the anesthesia becomes more thorough and more prolonged, and can be obtained even in inflamed areas.

Schleich uses three solutions:

No. 1, a strong solution, which is used in inflamed areas: cocain hydrochlorate, gr. iij; morphin hydrochlorate, gr. $\frac{2}{5}$; sodium chlorid, gr. iij; distilled sterile water, ℥iij$\frac{2}{5}$; phenol (5 per cent.), 2 drops.

No. 2, a medium solution, which is employed in most cases: cocain hydrochlorate, gr. iss; morphin hydrochlorate, gr. $\frac{2}{5}$; sodium chlorid, gr. iij; distilled sterile water, ℥iij$\frac{2}{5}$; phenol (5 per cent.), 2 drops.

No. 3 is the weak solution used to infiltrate extensive areas: cocain hydrochlorate, gr. $\frac{1}{6}$; morphin hydrochlorate, gr. $\frac{2}{5}$; sodium chlorid, gr. iij; distilled sterile water ℥iij$\frac{2}{5}$; phenol (5 per cent.), 2 drops.

The injections are begun *in* the skin, not *under* it (Fig. 343), and are made one after another until the area to be operated upon is surrounded above, below, and on all sides with Schleich's solution. This infiltration can be made painlessly by touching with pure carbolic acid the point where the needle is to be inserted, or by freezing this area with ethyl chlorid. When deeper tissues are reached they are

infiltrated before incising them. If a nerve comes in sight, touch it with a drop of pure carbolic acid (Lund). Van Hook says that the anesthesia obtained by this method is due to artificial ischemia, pressure upon the tissues, the

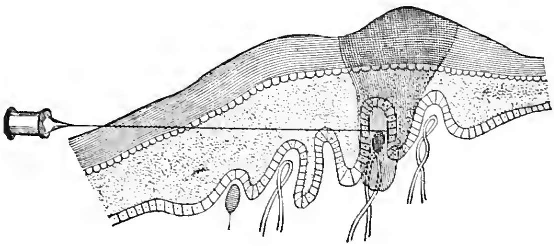


FIG. 343.—The syringe-point stops at the papillary layer, and the fluid lodges in the skin itself (Van Hook).

direct action of the drugs, and the lowered temperature.[1] The method is very efficient, and can be used for operations of considerable magnitude.

Cocainization of the Spinal Cord.—Bier has produced complete anesthesia of the entire body except the head by the injection of a small amount of 0.5 per cent. or 1 per cent. solution of cocain into the subdural space of the cord. The needle is inserted as in lumbar puncture, care being taken to prevent the escape of cerebrospinal fluid. The anesthesia begins in five minutes, and lasts for forty-five minutes. In this condition surgical operations can be performed without causing pain. Among the operations which have been performed are resection of the knee, resection of ankle, osteotomy (Bier); amputation of the leg (Lower); hysterectomy (Tuffier). This method is usually followed by vomiting and headache; its safety has not been determined, and the real value of the method is as yet uncertain.

XXX. BURNS AND SCALDS.

Burns and scalds are injuries due to the action of caloric. Scalds are due to heated fluids or vapors. There is no true pathological difference between burns and scalds. Dupuytren classifies burns into six degrees as follows: (1) characterized by erythema; (2) characterized by dermatitis with the formation of vesicles; (3) characterized by partial destruction of the skin, which structure is not, however, entirely burnt through; (4) characterized by destruction of

[1] *Med. News*, Nov. 16, 1895.

the skin to the subcutaneous tissue; (5) characterized by destruction of all superficial structures and of part of the muscular layer; (6) characterized by "carbonization" of the whole thickness of the muscles.

The **symptoms** of a severe burn are local and constitutional. *Local symptoms* are pain and inflammation, which vary in nature, in intensity, or in degree according to the extent of tissue-damage. *Constitutional symptoms* are very weak pulse, shallow respiration, and subnormal temperature,—in other words, the condition of shock exists. The patient may die without reacting from shock, but in most cases there is reaction, followed by a severe reactionary fever, with a strong tendency to congestion of internal parts. During the existence of fever there may be vomiting, diarrhea, hemoglobinuria, and enlargement of the liver, spleen, lymph-glands, and tonsils. If over two-thirds of the body surface is badly burnt, death will certainly occur, and probably within two days. Death after severe burns is positively not due to loss of body-heat in the burnt area, nor to auto-intoxication with retained body-secretions. High temperature produces blood-changes,—viz., disintegration of red corpuscles. Thrombosis may occur, and irritation of the kidneys and other organs is produced by "products of corpuscular degeneration."[1]

The blood of burned animals contains toxins (Kijanitzen), and so does the urine (Reis). It seems probable that the constitutional symptoms and death, if it occurs, are due partly to corpuscular disorganization, and partly to the absorption of toxic matter from the seat of injury, this matter having been formed by the action of heat on the body-cells and fluids. Sepsis is not infrequent. The symptomatic stages are often designated as *prostration*, *reaction*, and *suppuration*. Death may be directly due to shock, to sepsis, to exhaustion, to embolism or thrombosis, to congestion of the brain, lungs, or kidneys, or to Curling's ulcer of the duodenum.

Treatment.—The *local treatment* of slight burns (as sunburn) is to moisten the parts frequently with a saturated solution of bicarbonate of sodium, a solution of citrate of lime, or a 1 : 8 solution of phénol sodique. In burns of moderate degree a mixture of zinc ointment with iodoform, though not antiseptic, is a comfortable dressing.

If a large surface is burnt, remove the clothing with great care, and before applying dressings, give a hypodermatic

[1] Bardeen, in *Johns Hopkins Hospital Bulletin*, April, 1897.

injection of morphin, administer stimulants, and if the patient has a chill place him in a warm bath. If we desire to dress a large burn aseptically, anesthetize the patient, spray the burnt area with peroxid of hydrogen, irrigate it with a solution of boric acid, dry with sterile cotton, dust with iodoform or with Senn's powder (three parts of boric acid and one part of salicylic acid), and dress with salicylated cotton. Change the dressing no oftener than is required, and at each change proceed as above described, although it will not be necessary to anesthetize. The custom in the Jefferson Medical College Hospital is to give morphin and stimulants, to cut away the clothing, to wrap the unburnt parts with blankets, and place about them cans or bags of hot water. The burnt region is sprayed with peroxid of hydrogen contained in an atomizer, and irrigated with salt solution. Portions of epidermis which remain are retained. Any blisters are opened with a sterile needle, and the part is dressed with several layers of sterile lint or tarlatan soaked in normal salt solution, and the dressing is kept moist.

The picric acid treatment, first suggested by Thiery, has many advocates. It should be used early only in limited burns of the first and second degrees, but it can be used in late stages of deep burns to stimulate the formation of epidermis. If used early in a large or a deep burn, it may poison the patient (may produce carboluria). The part should be disinfected, gauze saturated with a 1 per cent. watery solution of picric acid should be laid upon the burnt area, and be covered with absorbent cotton and a bandage. This dressing is not changed for three to five days, and the next dressing can be left in place until the burn is healed. D'Arcy Power has carefully studied the real status of picric acid as a remedy for burns, and some of his conclusions have been set forth above.

Périer dresses a burn with a tarlatan compress, folded six times and soaked in the following solution: boric acid, ʒijss; antipyrin, ʒjss; sterile water, ℥viij. The following ointment is used by Reclus: iodoform, gr. xv; antipyrin, gr. lxxv; boric acid, gr. lxxv; vaselin, ℥jss.

Carron oil consists of equal parts of linseed oil and lime-water. It allays the pain of a burn, but it is a filthy preparation, and its use is followed by much pus-formation. Cosmolin gives comfort as a dressing, but should not be used on the face lest it cause pigmentation. The elder Gross used lead paint. A solution of nitrate of potassium

allays the pain. Where extensive destruction of tissue has taken place use splints and extension to limit contractures, and skin-graft as soon as possible. If granulation is slow, stimulate with copper-sulphate or mild silver-nitrate solutions. Exuberant granulations require burning down. Flabby granulations require pressure. If healing is slow, or if the burn is extensive, skin-graft. When an extremity has been carbonized amputation must be performed. The *constitutional treatment* is to bring about reaction; combat pain with opium; and keep the bowels and kidneys active. If suppuration occurs, give tonics, stimulants, and concentrated foods. Complications are treated according to general rules.

Scalds of the glottis are due to the inhalation of steam or of ignited gas. A child may scald the glottis by trying to drink from the spout of a kettle (Moullin).

The **symptoms** are pain, dysphagia, and dyspnea. Edema of the glottis comes on quickly.

The **treatment** is tracheotomy or intubation of the larynx in severe cases; in mild cases, scarification of the larynx.

Effects of Cold.—*Local Effects.*—Cold produces numbness, pricking, a feeling of weight, redness of the surface followed by stiffness, local insensibility, and mottling or pallor. Sudden intense cold causes the formation of blebs, the coagulation of blood in the superficial veins, and violent pain in the limb. Cold locally produces frost-bite (page 162).

The *constitutional effects* of cold are at first stimulating, then depressing, and are exhibited by uneasiness, pain, and an intense drowsiness which, if yielded to, is the road to death by way of internal congestion. Death from prolonged cold resembles in appearance death from apoplexy. Death from sudden and overwhelming cold is caused by anemia of the brain from weak circulation and capillary embolism. To bring a partly-frozen person into a warm room may cause death by embolism.

Treatment.—Frost-bite is treated as outlined on page 162. When a person is nearly frozen to death place him in a *cool* room, but under no circumstance in a cold bath, make artificial respiration, rub him briskly with flannel soaked in alcohol or in whiskey, and follow this by rubbing with dry hands. After a time wrap the patient in warm blankets and give an enema of brandy. Mustard plasters are to be applied over the heart and spine. As soon as swallowing is possible brandy is administered by the mouth. As the condition

improves gradually raise the temperature of the room and give *hot* drinks.

Chilblain, or **pernio,** is the secondary effect of cold. It usually appears as a local congestion upon the toes, the ears, the fingers, or the nose, and it is apt now and then to inflame and ulcerate. A chilblain is apt to become congested by approaching a fire or by taking exercise, and when congested it itches, tingles, and stings. Frequent attacks of congestion produce crops of vesicles; these vesicles rupture and expose an ulcer, which in rare instances sloughs.

Treatment.—If chilblain affects the toes, prevent congestion of the legs and feet. Order large shoes and woollen stockings, and forbid tight garters. The patient with pernio must take regular outdoor exercise and must not loiter around a hot fire. Every morning and evening he should take a general cold sponge-bath, following by rubbing with alcohol and frictions with a coarse towel, and in winter he should sleep with warm stockings on or with his feet upon a hot-water bag. When a chilblain is only a congested spot it should be washed twice a day in cold salt water, rubbed dry with flannel, and subjected to applications of tincture of iodin and soap liniment (1 : 2), tincture of cantharides and soap liniment (1 : 6), or equal parts of turpentine and olive oil (W. H. A. Jacobson). Jacobson says itching is relieved by painting belladonna liniment upon the part and allowing it to dry. If vesicles form, paint with contractile collodion; if ulcers form, dress antiseptically. If ulcers are sluggish, use equal parts of resin cerate and spirits of turpentine. A good antiseptic and protective is the following: oxid of zinc, gr. vj; chlorid of zinc, gr. xx; gelatin, ℥ij; distilled water, ℨj.

XXXI. DISEASES OF THE SKIN AND NAILS.

Dermatitis venenata results from irritants and from garments containing arsenic, but is generally due to rhus-poisoning. Rhus-poisoning arises from the poison-oak, the poison-ash, the poison-ivy, and other species of sumach. Actual touching of the plants is not always necessary.

The **symptoms** are burning and itching, redness and edema of the face and hands. A vesicular eruption begins between the fingers, and the eruption and the inflammation spread widely over the body. There may be slight fever.

The **treatment,** when a moderate area is involved, comprises the application of cloths wet with black wash or lead-

water and laudanum. If an extensive area is involved, apply grindelia robusta (ʒiv to Oj of water) or moisten the surface frequently with sweet spirits of niter. Oxid-of-zinc ointment containing 10 gr. of carbolic acid to ℥j gives great relief. A 1 : 8 solution of phénol sodique allays pain and itching.

Furuncle, or **boil,** is an acute and circumscribed inflammation of the deep layer of the true skin and the subcutaneous cellular tissue following on bacterial infection of a hair-follicle or a sebaceous gland. A boil is caused by infection of a hair-follicle, through a slight wound (by scratching, shaving, etc.), with the staphylococcus pyogenes aureus. Boils are very common in individuals with Bright's disease, diabetes, gout, tuberculosis, and disorders of menstruation and digestion; and crops of boils are apt to appear during convalescence from typhoid fever. Boils are commonest in the spring, and sometimes an epidemic of furunculosis appears in a hospital, a jail, or an asylum.

The **symptoms** of a boil are as follows: a red elevation appears, which stings and itches; this elevation enlarges and becomes dusky in color; a pustule forms, that ruptures and gives exit to a very little discharge which forms a crust. Inflammatory infiltration of adjacent connective tissue advances rapidly, and the boil in about three days consists of a large, red, tender, and painful base capped by a pustule and a little crusted discharge. In rare instances, at this stage, absorption occurs, but in most cases the swelling increases, the discoloration becomes darker, the skin becomes edematous, the pain becomes fierce and pulsatile, and the center of the boil becomes raised. About the seventh day rupture occurs, pus flows out, and a "core" of necrosed tissue is found in the center of a ragged opening. This core consists of the sebaceous gland and hair-follicle, which have undergone coagulation-necrosis (Warren). In a day or two more the core will be discharged, and healing by granulation will occur. A *blind boil* lasts only three or four days and has no core. The constitution often shows reaction during the progress of a boil. Boils may be either single or multiple. The development of one boil after another, or the formation of several boils at once, is known as "furunculosis." Boils are commonest upon the neck and the back.

The **treatment** consists of crucial incision, removal of necrotic tissue, irrigation with peroxid of hydrogen and corrosive sublimate, and the application of hot antiseptic fomentations.

Aleppo boils (endemic boils of the tropics) are papules appearing upon the exposed parts of the body. These papules, which ulcerate and do not cicatrize for at least a year, are due to a pathogenic bacterium and leave ineradicable scars.

Carbuncle (benign anthrax) is a circumscribed infectious inflammation of the deeper layer of the true skin and of the subcutaneous tissue, with fibrinous exudation, multiple foci of necrosis arising, and the tissue adjacent to each necrotic plug becoming gangrenous. The infection takes place through a hair-follicle. It is really a boil with extensive infiltration of adjacent tissues. A boil may become a carbuncle, and pus from a carbuncle inoculated into a healthy person may cause either a boil or a carbuncle. The causative organism seems to be the staphylococcus pyogenes aureus. Carbuncles are most common in the spring of the year. In persons with diabetes and Bright's disease carbuncles not unusually occur.

The local **symptoms** in the beginning resemble those of a boil, but the constitution sympathizes from the very start (a chill and a septic fever) and the pain is usually severe. The inflammatory area begins as a papule with an indurated base, it enlarges enormously, is boggy to the touch, is dusky in color, is edematous, and the skin is not freely movable over the deeper parts. In a few days many pustules appear, each pustule marking the site of a focus of necrosis. Large vesicles filled with bloody serum very frequently form. In some cases, about the tenth day, the pustules rupture, the necrotic plugs are discharged, and the case slowly progresses toward cure; but in many cases the carbuncle spreads at the periphery while pustules are rupturing near the center of inflammation, and pus forms in the deeper tissues, reaching the surface through many small openings, each of which is partly blocked by a plug of dead tissue. A carbuncle in this stage resembles a honeycomb, discharges bloody pus, and large masses of skin and subcutaneous tissue are destroyed. The entire carbuncular mass may become gangrenous, and a sudden and almost complete cessation of pain points to this complication. An ordinary carbuncle remains acute for about three weeks, but healing requires a month more. The most dangerous situations in which to have a carbuncle are the face and neck (tends to produce septic phlebitis, septic clots in the cerebral sinuses, or infective emboli). The most usual positions for carbuncle are the neck, the back, and the buttocks. The diagnosis of car-

buncle is made by noting the multiple foci of necrosis and the profound constitutional involvement. A carbuncle may produce death by causing septicemia, pyemia, or profuse hemorrhage.

Treatment.—Some have suggested the treatment of a carbuncle in an early stage by injecting from five to thirty drops of carbolic acid (80 per cent.) into and around the inflammatory mass. The best treatment is thorough extirpation while the patient is anesthetized. The entire area of the infection is thus removed, and the large wound heals by granulation and is subsequently skin-grafted. A useful plan, frequently employed, is as follows:

Give ether, make free crucial incisions, remove dead and necrosing tissue with the scissors and forceps, curet pockets, arrest hemorrhage by pressure and hot water, cauterize with *pure* carbolic acid, dust with iodoform, pack with iodoform gauze, and dress with hot antiseptie fomentations. Cover the gauze with a piece of some impermeable material and lay a hot-water bag upon the dressing. Every day, or several times a day, remove the dressings, wash with peroxid of hydrogen, irrigate with corrosive-sublimate solution, dust with iodoform, and reapply the iodoform gauze and antiseptic fomentation. Keep up this treatment until sloughs are separated, and then dress with dry antiseptic gauze. Secure sleep by morphin, give quinin, milk-punch, and nourishing diet, and attend to the bowels and kidneys.

Clavus, or Corn.—A corn is a tender, painful, and circumscribed thickening of the epidermis, and is commonest over one of the joints of the toes. *Hard* corns are situated on exposed parts of the digits; *soft* corns appear between the digits, where the parts are kept constantly moist. Corns are caused by pressure.

Treatment.—By wearing well-fitting boots corns upon the toes will usually disappear. Soak the feet often in water containing bicarbonate of sodium, dry them, and apply a circular corn-plaster to the corn to take off the pressure of the boot. Another method is to touch the corn with iodin every night and pare away the hard tissue every morning. An old and valuable plan is to paint the corn every night with a mixture composed of salicylic acid, ʒiss; extract of cannabis indica, gr. x; and collodion, ʒj, and to scrape this mixture away every morning. *Soft* corns are treated by washing the feet often with ethereal soap, drying, gently removing the sodden epithelium, dusting the toes with borated talc, and placing absorbent cotton between the

digits. Incurable soft corns require the removal of the skin from the adjacent sides of the two toes and suturing them together (thus converting two toes into one). In inflamed corns employ rest and lead-water and laudanum, and let out pus when it forms. Remember that in old persons the cutting of a corn may cause senile gangrene. In the inflamed and painful feet of a person who has corns nothing gives so much relief as washing the feet with ethereal soap, soaking in hot water, and wrapping the feet for half an hour in cloths wet with a mixture composed of linseed oil and lime-water, each, ℥ij, and spirits of camphor, ℥j.

Warts.—(See page 291.)

Onychia is inflammation of the matrix of the nail. A "run-around" is suppuration of the matrix and the root of the nail, of traumatic origin. It requires incision, trimming away of the buried edge of the nail, and packing with iodoform gauze.

Malignant onychia, which is inflammation and ulceration of the entire matrix, occurs only in a person of dilapidated constitution. This condition requires removal of the entire nail, cauterization of the matrix, dressing with iodoform gauze, and the internal use of stimulants, tonics, and nourishing diet.

Ingrown toe-nail is due either to lateral hypertrophy of the edge of the nail or to the forcing of the soft tissues over the margin of the nail. The condition is treated by splitting the nail, removing the piece of nail, the soft tissue, and the adjacent matrix, and dressing antiseptically.

XXXII. DISEASES AND INJURIES OF THE THYROID GLAND.

Wounds cause violent hemorrhage which is difficult to arrest. Ligatures may cut out and forceps will not hold. The hemorrhage is arrested by suture-ligatures, purse-string sutures, the actual cautery, or removal of the bulk of the gland.

The thyroid gland may be **absent** at birth. **Congenital atrophy** or **congenital hypertrophy** may exist.

Acquired atrophy leads to myxedema, a condition characterized by the presence of a firm subcutaneous swelling in the face, neck, and limbs; slow speech; mental dulness; and subnormal temperature. The condition is identical with that produced by removal of the entire gland (cachexia strumapriva).

Cretinism is a form of idiocy due to atrophy of glandu-

lar elements in the thyroid, although the size of the gland is often increased. The body is dwarfed; the face, neck, and extremities resemble those parts in myxedema, and a low grade of idiocy exists. Myxedema and cretinism are treated by the internal administration of thyroid extract.

Congestion of the thyroid may be caused by violent exertion, prolonged effort, febrile maladies, and venous obstruction. It is treated by removing the cause and applying heat locally. Tracheotomy may be required.

Inflammation of the thyroid (acute or inflammatory goiter) may be caused by a septic or febrile malady, rheumatism, muscular strain causing vascular rupture, a wound or contusion of the thyroid. But one lobe is affected. The ordinary symptoms of inflammation are present. In addition there are dysphagia, dyspnea, venous congestion of the face, epistaxis, nausea and vomiting, and possibly delirium. It may terminate in resolution, suppuration, or fibrous induration.

Goiter.—A goiter is an enlargement of the thyroid gland not due to malignant tumor or to inflammation. Goiter may affect a portion of one lobe, both lobes, or both lobes and the isthmus, and it may occur sporadically or endemically. In Switzerland it is very common. Among the alleged causes are the playing of wind-instruments, the drinking of snow-water, and the use of water impregnated with the salts of lime. Hereditary influence is frequently noted. The forms of goiter are as follows: *simple hypertrophy*, a hypertrophy of the gland-tissue, usually symmetrical, in reality an adenoma; *cystic goiter* or *bronchocele*, in which cysts form in hypertrophied glands, or rarely in non-hypertrophied thyroids, the cysts being either single or multiple, being due to mucoid or colloid degeneration, and containing a fluid sometimes clear and thin, sometimes viscid, and often coffee-ground in character; and *fibrous goiter*, a fibrous induration which is apt to arise in old bronchoceles, and which may pass into a calcareous condition. Parenchymatous goiter is enlargement of the whole gland. By the term malignant goiter we mean malignant disease of the thyroid gland, either sarcoma or carcinoma.

The **symptoms** are—congestion of the head and neck from enlargement of veins; occasionally cerebral symptoms (anemia, syncope, even convulsions) from pressure on carotids; irritation of recurrent laryngeal nerve (causing spasm of the glottis or laryngeal paralysis); compression of the trachea (causing dyspnea). Rapidly-growing goiters are often fatal;

slow-growing goiters are rarely fatal. A goiter moves up and down as the patient swallows. A malignant goiter grows rapidly, becomes adherent, infiltrates, and quickly produces metastasis. Both sarcoma and carcinoma produce metastasis by way of the venous system.

Treatment.—Iodid of potassium and arsenic internally have been advised; ointment of red oxid of mercury locally is advocated by some writers. The local use of iodin benefits many cases. The administration of thyroid extract may do much good. Cystic goiters may be aspirated and injected with a solution of iodin. Electrolysis may benefit a soft goiter, the negative pole being pushed into the growth, the positive pole being applied to its surface. In considering the propriety of operation remember that a goiter which begins at puberty may pass away. We should operate on every non-malignant goiter which is increasing rapidly in size, and on every goiter which causes much respiratory trouble, but should not operate simply for deformity (Bergeat). If enucleation or extirpation is performed, do not give ether or chloroform. These agents greatly increase bleeding, and are dangerous. Do the operation with the aid of local anesthesia (cocain, eucain, or Schleich's fluid). It is a great advantage to have the patient conscious, because by asking him to speak during the operation the surgeon can tell if the recurrent laryngeal nerve is being touched. In most cases intraglandular enucleation is performed, in some cases extraglandular enucleation, in other cases these two methods are combined (Bergeat). Ligation of the thyroid arteries has been recommended. Enucleation, if possible, is the desirable operation. It may easily be employed for the removal of a single colloidal or cystic area (Socin). Thyroidectomy or extirpation is employed when enucleation is impossible. The entire thyroid is not removed for an innocent growth; a portion of the gland is left behind, otherwise myxedema will arise (Kocher). Unilateral extirpation is the usual method. In sarcoma or cancer of the thyroid complete extirpation may be attempted. The operation will occasionally prolong life, but it will rarely effect a cure.

Exophthalmic Goiter (Graves's Disease; Basedow's Disease; Pulsating Goiter).—In a typical case there are rapid pulse, protrusion of the eyeballs, and enlargement of the thyroid gland; but any one of these conditions may be absent. The enlargement may be unilateral, but is usually bilateral. A systolic bruit is usually audible over the thyroid region. Von Graefe's sign may be present; this consists of retraction

of the eyelids, and inability of the lids to follow the eyes in looking down. The lids in some cases cannot be completely closed, and when the eyeball is suddenly turned up the lid and brow may fail to act together. In some cases the lids pulsate, in some ocular palsies exist, in others photophobia or nystagmus. Patients may suffer from neuralgia, colic, choreic movements, tremor, flushes of heat, and gastric crises. Dyspnea often exists, and albuminuria and polyuria are not uncommon. Hemoptysis, hematemesis, or mental disturbance is sometimes noted.

Exophthalmic goiter may arise after emotional excitement or depression, during pregnancy, or during the existence of locomotor ataxia, paresis, epilepsy, neurasthenia, hysteria, and other nervous troubles. The condition is a vasomotor ataxia (Cohen). Its real cause is uncertain; but is probably the action upon the sympathetic system of some poisonous product of thyroid action.

Treatment.—Thyroid extract more often does harm than good. Electricity is said to be of benefit. Most cases are treated by improving the general health and employing digitalis. Thymus extract and suprarenal extract have been used by some. Extirpation of the cervical ganglion of the sympathetic, and division of the nerve below the ganglion, have been employed, and it is alleged with benefit (Jaboulay). Ligation of the thyroid arteries may do good. Incomplete removal is the operation commonly employed in severe cases; it has cured 80 per cent. of the cases operated upon. In some cases thyroid intoxication follows operation. In other cases very rapid growth follows incomplete removal, and the operation seems actually to have done harm. Sudden death occasionally follows the operation of thyroidectomy. The removal of an exophthalmic goiter is difficult; the capsule and blood-vessels rupture from slight force, and the use of ether and chloroform is very dangerous. All cases should not be operated upon; in fact, only those cases should be operated upon in which medical treatment has proved futile, or in which there is profound toxemia or excessive dyspnea. If the operation is performed, neither ether nor chloroform should be given, as either of these agents will greatly increase bleeding and prove dangerous. Operation is to be done under local anesthesia (eucain, cocain, or Schleich's fluid).

XXXIII. DISEASES AND INJURIES OF THE LYMPHATICS.

Lymphangitis is inflammation of lymphatic vessels. *Reticular* lymphangitis, which is inflammation of lymphatic radicals, is seen in some circumscribed inflammations of the skin. It is apt to attack the hands, causing redness and swelling, fading at the point of initial trouble while it spreads at the periphery; it is caused by micro-organisms derived from decomposing animal matter (Rosenbach). Erysipelas also causes it (see Erysipelas). *Tubular* lymphangitis, which is due to the entry into the lymphatic ducts of virulent micro-organisms or toxic materials, is seen after dissecting-wounds, septic wounds, snake-bites, etc. It is announced by edema and by minute, hard red streaks running from the wound up the extremity. Suppuration may occur.

Infective lymphadenitis, or inflammation of the glands, may follow lymphangitis or may be due to the deposition of infective material, the lymph-vessels not being inflamed. In septic lymphadenitis there are pain, tenderness, and swelling; in severe cases there is a chill and a septic fever. Suppuration may arise. The *treatment* is to drain and asepticize the wound, to apply iodin, blue ointment, or ichthyol over the glands and vessels, and to employ rest and compression. Internally, milk punch, quinin, and nourishing diet are required. If the glands do not rapidly diminish in size after disinfection of a wound, and if they are in an accessible region, extirpate them. If suppuration of the glands occurs, incise and drain.

Acute lymphadenitis, or acute inflammation of the lymphatic glands, may be due to tubercle, syphilis, glanders, cold, or traumatism. Suppuration may or may not occur. In inflammatory lymphadenitis there are pain, heat, and nodular swelling. In severe cases there is fever.

The *treatment* is to asepticize any area of infection, place the glands at rest, apply cold and ichthyol ointment, or inject into the gland every day 5 minims of a 3 per cent. solution of carbolic acid to prevent suppuration. If the glands do not rapidly shrink, extirpate them. If pus forms, evacuate, drain, and asepticize.

Chronic lymphadenitis is almost invariably syphilitic or tubercular. It requires constitutional treatment and the local use of ichthyol, iodin, or blue ointment. If these remedies are not rapidly successful, tubercular glands should be

removed, but syphilitic glands will rarely require such radical treatment.

Lymphangiectasis (varicose lymphatics), or dilatation of the lymphatic vessels, is due to obstruction. It results, as a rule, from chronic lymphangitis or the pressure of a tumor, and is most usually situated in the pubic, the inguinal, or the scrotal region, or on the inner side of the thigh. There are two forms: the *varicose*, in which the vessels have a tortuous outline, like varicose veins, but are covered only with surface-epithelium; and *lymphatic warts* (lymphangioma circumscriptum), in which wart-like masses spring up, these masses being covered with epithelium and filled with lymph. In most cases of lymphangiectasis there is considerable hard edema. Rupture of the dilated vessel causes a flow of lymph (*lymphorrhea*).

Lymphangioma is an advanced stage of lymphangiectasis (p. 284).

The **treatment** in mild cases is to pierce each vesicle with the negative pole of a galvanic battery and pass a current. In severe cases destroy the mass with the Paquelin cautery or excise it with a knife or with scissors.

Elephantiasis.—*True* elephantiasis (elephantiasis Arabum) is chronic hypertrophy of the skin and subcutaneous tissues following upon a lymphangiectasis produced by a nematode worm (the filaria sanguinis hominis).

Spurious elephantiasis is hypertrophy of the skin and subcutaneous tissue due to chronic inflammation (in a leg which possesses an ancient ulcer, or in the scrotum of a man with urinary fistula).

The **treatment** is massage and bandaging, sometimes ligation of the artery of supply, extirpation, or amputation.

Tubercular Glands (p. 196).

Lymphadenoma (*Malignant Lymphoma; Hodgkin's Disease; Pseudoleukemia*).—The term lymphoma is used to loosely designate any persistent swelling of a lymphatic gland or glands. Lymphadenoma means a swelling of lymph-glands or lymphadenoid tissue, which swelling is progressive in character, involves group after group of glands, is associated with anemia, and often accompanied by secondary growths in the abdominal viscera. Fig. 344 exhibits a case of Hodgkin's disease.

This disease is most common in those under forty, and affects males far more frequently than females. In many cases the disease arises slowly in apparently healthy glands and exists for some time before it takes on signs of malig-

nancy and invades distant glands. A gland enlarged from irritation or from tubercular disease may become lymphadenomatous, and tubercle bacilli can sometimes be found in lymphadenomatous glands. In some cases the disease has a tendency to generalization from the start; in others it appears to remain localized for many months It has been thought by some that there is an infective element which is

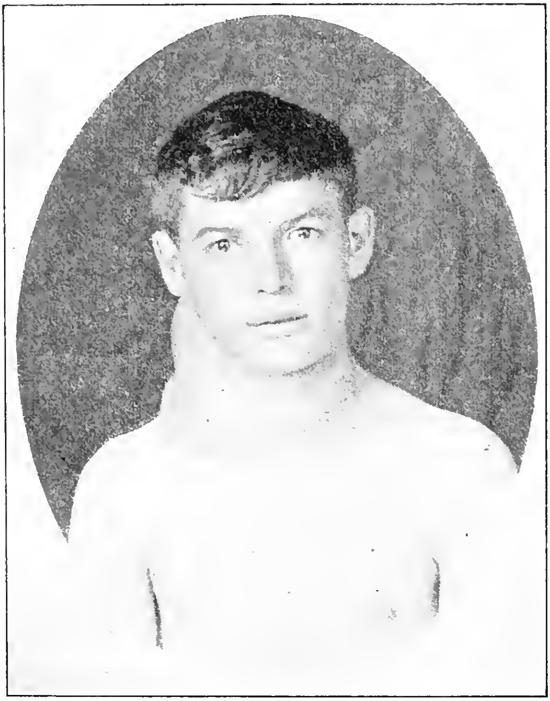


FIG. 344.—Hodgkin's disease.

responsible for the disease, but causative organisms have not been found.

Symptoms.—The glands in the neck are usually involved first, but the disease may begin in the axillary glands, the thoracic glands, or the intra-abdominal glands.

Two or more regions are sometimes involved simultaneously or almost simultaneously.

When the disease begins in the neck, it affects at first one side, and after many weeks or months the other side becomes involved. The glands are at first hard, separated from each

other, movable, and the skin moves freely over them. Later the large glands weld together and form great masses upon both sides of the neck and in the axillæ which may obstruct respiration.

After a time a very large mass may soften, and in very rare cases the skin becomes adherent and finally breaks. Intrathoracic symptoms point to involvement of the thoracic glands. It may be possible to palpate abdominal glands.

The spleen is enlarged; the thyroid may be enlarged; anemia is usually but not invariably present, and if it exists, there are the ordinary symptoms which go with it, viz., palpation, breathlessness, indigestion, vertigo, headache, pallor, and sometimes epistaxis. Occasionally, without obvious reason, the glands suddenly increase in size, or rapidly undergo a notable but temporary diminution.

Osler says slight fever exists in almost all cases, and sometimes there are paroxysms like ague.[1]

Diagnosis.—In a widespread case the diagnosis is easy; in a localized case it is difficult. Tubercular glands are most apt to first appear in the submaxillary triangle; lymphadenomatous glands, in the root of the neck or in the occipital triangle. Tubercular adenitis is most common in children. As a rule, tubercular glands caseate, but they may remain localized for years if caseation does not occur. The tubercular glands usually soon become adherent and immovable. Lymphadenoma is most common after twenty, rarely remains localized for more than a few months, rarely softens unless very large, and the glands are separated and movable until a huge mass forms. Early softening, prolonged limitation to one region, and absence of pronounced anemia in a person under twenty point to tubercle. In doubtful cases a gland should be removed for microscopical and bacteriological study.

Prognosis.—The disease is almost always, if not invariably, fatal. Most cases die within three years, some die within six months, some few live four or five years or more.

Treatment.—If the glands are localized to one side of the neck, or even to both sides of the neck, remove them. Early removal before dissemination has occurred may possibly save the patient. If early or radical removal is not possible, do not operate, but treat the patient with nutritious food, tonics, and courses of arsenic.

[1] Osler's *Practice of Medicine.*

XXXIV. BANDAGES.

A bandage is a fibrous material which is rolled up and is then employed to retain dressings, applications, or appliances to a part, to make pressure, or to correct deformity. It may be composed of plain gauze, of gauze infiltrated with plaster-of-Paris or soaked in silicate of sodium, of gauze wet with corrosive-sublimate solution, of flannel, of calico, or of unbleached muslin. Unbleached muslin, which is the best material for general use, is washed to remove the sizing, is torn into strips, and the edges are stripped of selvage. One end is folded to the extent of six inches, this is folded upon itself again and again until a firm center is formed, and over this center the bandage is rolled. In a well-rolled bandage the center cannot be pushed out of the roll. A roller bandage is divided into the initial end, which is within the roll, the body or rolled part, and the terminal end, which is free. In applying a bandage the outer surface of the terminal end is first laid upon the part.

A *cylindrical* part of the body may be covered by a *circular* bandage, each turn exactly covering the previous turns. A *conical* part may be covered by a *spiral* bandage, each turn ascending a little higher than the previous turn. As each turn of a spiral bandage is tight at its upper and loose at its lower edge, the *reverse* was devised to correct this inequality; hence a conical part should be covered by a *spiral reversed* bandage. To make a reverse hold the roller in the right hand, start the bandage obliquely upward (do not have more than six inches of slack), place the thumb across the fresh turn, fold the bandage down without traction, and do not make traction until the turn has been carried well around the limb. A projecting point is covered with *figure-of-8* turns. The groin, shoulder, breast, or axilla can be covered by figure-of-8 turns, each succeeding turn ascending and covering two-thirds of the previous turn and forming a figure like "the leaves on an ear of corn." Such a figure is called a "spica." In bandaging an extremity the peripheral turns should be tighter than the turns nearer the body. Never apply a tight bandage to the leg or the arm without including the foot or the hand. In firm dressings leave the ends of the fingers exposed, and use them as an index of the condition of the circulation in the part.

Spiral Reversed Bandage of the Upper Extremity.—To apply this form of bandage use a roller two and a half inches wide and eight yards long. Take a circular turn

about the wrist, and a second turn to hold the first; pass obliquely across the back of the hand to the extremities of the fingers; ascend the hand to the root of the thumb by several spiral turns; cover the wrist by ascending figure-of-8 turns; ascend the forearm by spiral reversed turns; cover the elbow by a figure-of-8, and the arm by spiral reversed turns; end the bandage by two circular turns, and pin them together (Fig. 345).

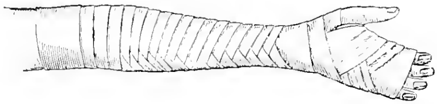


FIG. 345.—Spiral reversed bandage of the upper extremity.

Spiral Bandage of All the Fingers (Gauntlet).—The gauntlet bandage requires a roller one inch wide and one and a half yards long. Take two circular turns around the wrist, pass obliquely across the wrist to the root of the thumb, and descend to its tip by spiral turns; cover in the thumb by ascending spiral reverses, and return to the wrist. Cover in each successive finger in the same manner, and terminate by two circular turns around the wrist (Fig. 346).

FIG. 346.—Gauntlet bandage.

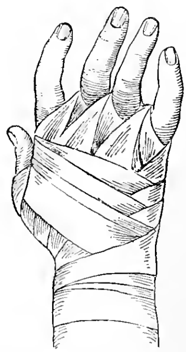


FIG. 347.—Demi-gauntlet bandage.

Spiral Bandage of the Palm or Dorsum of the Hand (Demi-gauntlet).—The demi-gauntlet requires a roller one inch wide and four yards long. This bandage has only a limited value; it must not be applied tightly, as it makes much pressure at the finger-roots, but leaves the fingers free. If it is desired to cover the palm, supinate the hand; if to cover the dorsum, pronate the hand. Take two circular turns

around the wrist, sweep around the root of the thumb, and return to the point of origin. Treat each finger in the same way. End by circular turns around the wrist (Fig. 347).

Spica of the Thumb.—For this bandage use a roller one inch wide and three yards long. Start at the wrist, and reach the tip of the thumb as in applying a spiral bandage of a finger. Make a series of ascending figure-of-8 turns between thumb and wrist, each ascending turn overlying two-thirds of the previous turn; terminate with a circular of the wrist (Fig. 348).

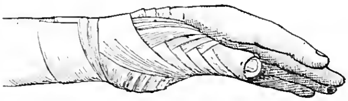


FIG. 348.—Spica of the thumb.

Selva's Thumb Bandage (Fig. 349).—Lay the terminal end of the bandage on the outer side of the second phalanx of the thumb, near the base of the phalanx. Carry it over

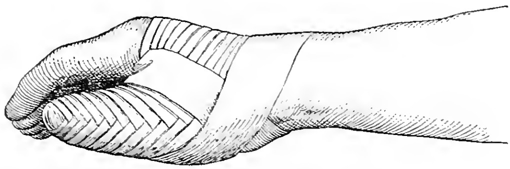


FIG. 349.—Selva's thumb-bandage applied.

the palmar side of the pulp of the last phalanx to the inner side of the second phalanx. The surgeon holds this turn in place with his left thumb and index finger. The roller is returned in a recurrent manner to its place of origin, overlaps the preceding turn, and is placed as much as possible on the dorsum. The roller is carried over the dorsum of the terminal phalanx and is turned around the tip, the loop crossing over the center of the nail. Figure-of-8 turns are now made over the dorsum of the hand, over the palm, and returning to the terminal phalanx, and an ascending spica is made.[1]

Spiral Reversed Bandage of the Lower Extremity.—Take a roller two and a half inches wide and seven yards long, and make two circular turns just above the malleoli, and an oblique turn across the dorsum of the foot to the

[1] *Medical News*, Sept. 28, 1895.

metatarsophalangeal articulation; make a circular turn, and cover the foot with ascending spiral reversed turns; return to the ankle by a figure-of-8; ascend the leg by spiral reverses; cover the knee by a figure-of-8, and the thigh by spiral reverses; terminate by two circular turns (Fig. 350).

Bandage of the Foot covering the Heel (American Bandage of the Foot).—Take a roller two and a half inches wide and seven yards long. The bandage is begun as is a spiral reversed bandage of the lower extremity. After the foot is well covered by ascending spiral reversed turns carry the bandage directly around the point of the heel and return to the instep; from this point carry it around the back of the ankle, down the side of the heel, under the heel, up to the instep, around the ankle in the opposite direction, down the opposite side of the heel, and under the heel and up to the instep; take the roller to above the malleoli, and end by a circular turn (Fig. 351).

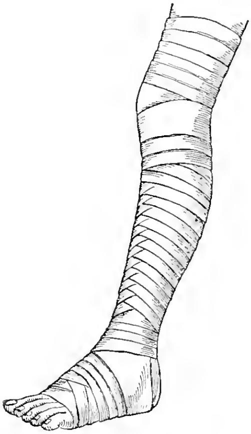


FIG. 350.—Spiral reversed bandage of the lower extremity.

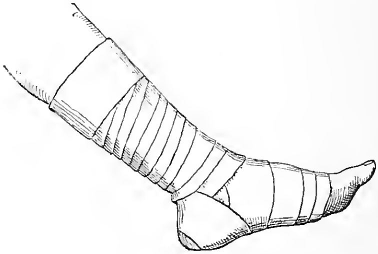


FIG. 351.—Method of covering the heel.

Bandage of the Foot not covering the Heel (French Method).—Take a roller two and a half inches wide and six yards long. Make a spiral reversed bandage of the foot and a figure-of-8 of the ankle-joint (Fig. 352).

Spiral Bandage of the Foot covering the Heel (Ribbail's Bandage; Spica of the Instep).—Take a roller two and a half inches wide and six yards long. Apply as a spiral reversed bandage of the lower extremity until the metatarsus is well covered. Carry the bandage, parallel with the margin of the foot (the inner or outer margin, according as to whether it is the left foot or the right), around the posterior aspect of the heel, along the opposite margin of the foot to cross the original turn at the median line of the dor-

sum. Make a number of these ascending turns, each turn covering in three-fourths of the previous turn; terminate by circular turns above the ankle (Fig. 353).

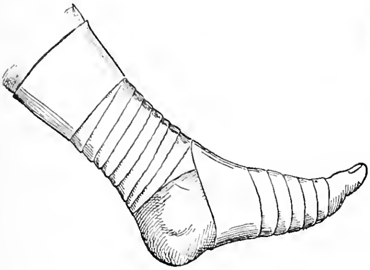


FIG. 352.—Figure-of-8 bandage of the ankle.

FIG. 353.—Spica of the instep.

Crossed Bandage of both Eyes (Figure-of-8 of both Eyes).—Take a roller two inches wide and six yards long. Make a circular turn around the forehead from right to left, a second turn to hold the first, a turn downward over the left eye, under the left ear, around the back of the neck, and upward under the right ear and over the right eye; repeat these turns, and terminate by a circular turn of the forehead (Fig. 354).

FIG. 354.—Crossed figure-of-8 bandage of both eyes.

FIG. 355.—Barton's bandage or figure-of-8 of the jaw.

Barton's Bandage (Figure-of-8 of the Jaw and Occiput).—Take a roller two inches wide and five yards long. Place the initial extremity of the bandage behind the inion; pass over the right parietal bone, across the vertex, down the left side in front of the ear, under the chin, up the right side in

front of the ear, across the vertex, and across the left parietal bone to the point of origin. A turn is now taken forward along the right side of the jaw to the chin, and backward along the left side of the jaw from the chin to the nape of the neck; repeat these turns, and pin the points of junction (Fig. 355). In Barton's bandage the ear lies in an uncovered triangle. The bandage may be finished by circular turns around the forehead. Barton's bandage is used for fracture of the lower jaw.

Borsch's eye-bandage is convenient and useful (Fig. 356). A narrow bandage is laid along the head and permitted to hang down the face in front of the sound eye. A circular bandage is applied around both eyes and over the narrow bandage (A). The narrow strip is lifted and pinned, and the sound eye is thus uncovered. Of course, the posterior end of A should first be pinned to the circular turn.

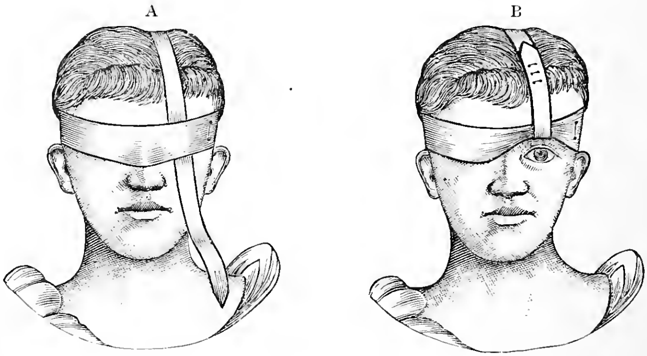


FIG. 356.—Borsch's eye-bandage: A, first step; B, second step.

Gibson's Bandage.—Take a roller two inches wide and six yards long. Make three vertical turns around the head and the jaw in front of the ear; reverse the bandage above the level of the ear, and carry it horizontally around the forehead and head three times; drop the bandage to the nape of the neck, and take three turns around the neck and jaw; terminate by taking from the nape of the neck a half turn upward, carrying the bandage forward to the forehead, and pinning it over the neck and over the forehead. Pin each point of junction (Fig. 357). Gibson's bandage is used for fracture of the lower jaw.

Crossed Bandage of the Angle of the Jaw (Oblique Bandage of the Jaw).—Take a roller two inches wide and six

yards long. Make a circular turn around the forehead toward the affected side, and a second turn to hold the first; take the turn to the back of the neck; carry it forward on the sound side, under the ear and chin; now make a series of turns around the head and jaw, in front of the ear on the injured side, but back of the ear on the sound side: these turns successively *advance* on the sound side only; terminate by going backward under the ear of the sound side to the nape of the neck, and then by taking two circular turns around

FIG. 357.—Gibson's bandage.

FIG. 358.—Oblique or crossed bandage of the angle of the jaw.

the forehead (Fig. 358). This bandage is used for fractures of the ramus of the jaw and for holding dressings upon the face and the cranium.

Spica of the Groin (Figure-of-8 of the Thigh and Pelvis).—For one groin the roller is three inches wide and seven yards long; for both groins, three inches wide and ten yards long. Take two circular turns, from right to left, around the waist, then down over the front of the right groin, around the back of the thigh, up over the front of the right groin, around the waist, down over the front of the left groin, around the back of the thigh, up over the left groin, and around the waist. The map being thus laid out, the turns are continued and ascended, each turn overlying one-third of the previous turn, and the bandage is completed by a circular turn around the waist (Fig. 359). Pin the crossed pieces.

Spica of the Shoulder.—Take a roller two and a half inches wide and seven yards long. Make a circular turn and several spiral reversed turns around the upper arm; then, coming from behind forward, carry the bandage over the

shoulder, across the front of the chest, through the opposite arm-pit, and return across the back to the shoulder. Make successive and advancing turns (Fig. 360).

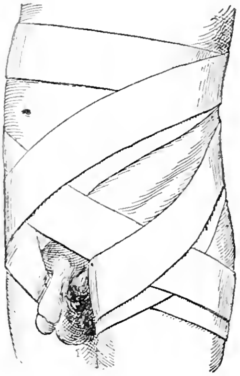


Fig. 359.—Spica of the groin.

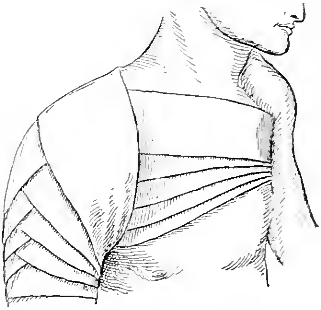


Fig. 360.—Spica of the shoulder.

Figure-of-8 bandages of the elbow, both shoulders (posterior figure-of-8), the neck and axilla, and of the breast are shown in Figs. 361, 362, 363, 368.

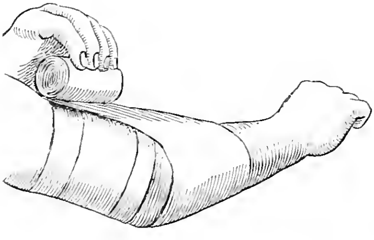


Fig. 361.—Figure-of-8 bandage of the elbow.

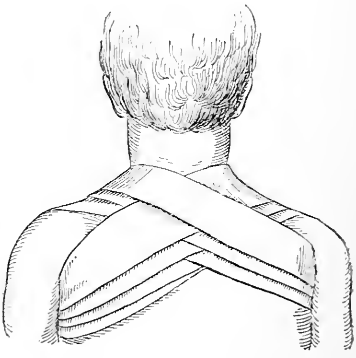


Fig. 362.—Posterior figure-of-8 of both shoulders.

Velpeau's Bandage.—Take a roller two and a half inches wide and ten yards long. Place the palm of the hand of the injured side upon the shoulder of the sound side, interposing cotton between the arm and the side. Start the bandage at the axilla of the sound side posteriorly, carry it across the back to the shoulder of the injured side, down the front of

the arm and under the arm just above the elbow, returning to the point of origin; repeat this turn, but, on reaching the axilla the second time, cross the back and pass around the chest, including the arm; keep on with these turns, each alternate turn going over the injured clavicle, each alternate turn encircling the arm and the body, the first turns advancing

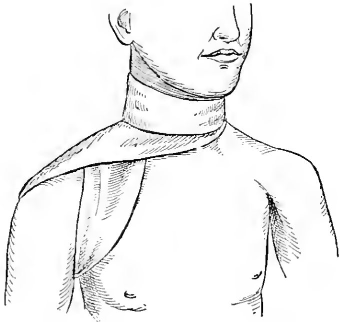


FIG. 363.—Figure-of-8 of neck and axilla.

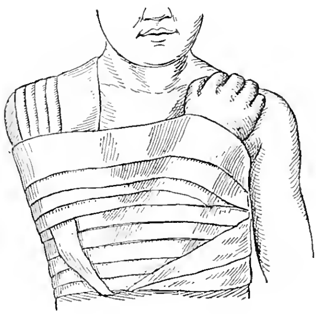


FIG. 364.—Velpeau's bandage.

and the second turns ascending (Fig. 364). Pin the crossed pieces. This bandage is used for fracture of the clavicle.

Desault's Apparatus.—This apparatus consists of three rollers, a pad, and a sling. Each roller is two and a half inches wide and seven yards long. The pad, which is

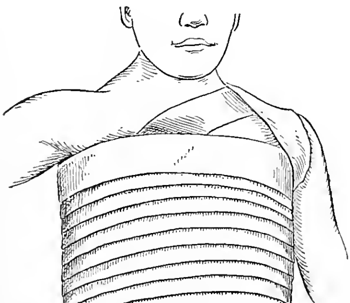


FIG. 365.—Desault's bandage, first roller.

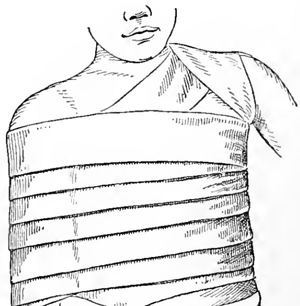


FIG. 366.—Desault's bandage, second roller.

wedge-shaped, is inserted into the axilla with the base up. The *first roller* is used to hold the pad (Fig. 365). The *second roller* binds the arm to the side over the pad. This

pad is a fulcrum, the shoulder is the weight, the arm is the lever, and the second roller of Desault corrects the inward deformity of a fractured clavicle (Fig. 366). The *third roller* corrects the downward and forward displacement. It starts in the axilla of the sound side anteriorly, crosses the chest to the shoulder of the injured side, runs down the

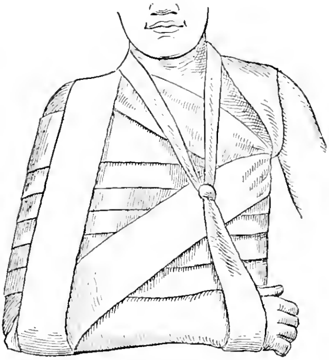


FIG. 367.—Desault's bandage, third roller.

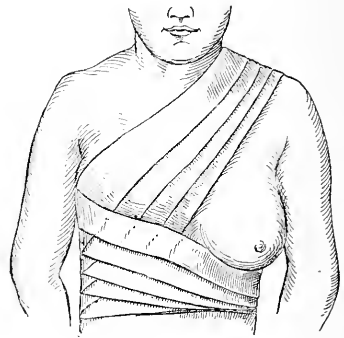


FIG. 368.—Figure-of-8 bandage of the breast.

back of the arm, around the elbow, and crosses the chest to the point of origin, forming the anterior triangle; it is now carried through the axilla of the sound side to the back, crosses the back to the shoulder of the injured side, runs down the front of the arm, around the elbow, and across the back to the axilla of the sound side, forming the posterior triangle (Fig. 367). The formula for the Desault bandage is: start in the axilla of the sound side anteriorly, run from the axilla to the shoulder, from the shoulder to the elbow, from the elbow to the axilla, and pass to the back; from the axilla to the shoulder, from the shoulder to the elbow, from the elbow to the axilla, and pass to the front. Pin the crossed pieces and hang the hand in a sling (Fig. 367).

Recurrent Bandage of the Head.—Take a roller two inches wide and six yards long. Make two circular turns horizontally around the forehead and head; when the middle of the forehead is reached, catch the bandage, take a half turn, carry the bandage to the occiput, let an assistant catch it, take a half turn, bring the roller forward to the forehead, covering a portion of the preceding turn; continue this process until the scalp is well covered; terminate with two circular turns around the forehead and head (Fig. 369). It is

often advisable to take a turn around the head and chin. Pin the crossed pieces.

FIG. 369.—Recurrent bandage of the head.

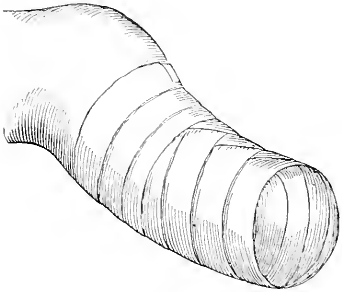


FIG. 370.—Recurrent bandage of a stump.

Recurrent Bandage of a Stump.—Take a roller two inches wide and six yards long. Make two light circular turns around the root of the stump; make recurrent turns covering the stump as is done in covering the head; take a circular turn around the root of the stump, oblique turns to the top of the stump, circular turns around the tip, and apply an ascending spiral reversed bandage (Fig. 370).

T-Bandage of the Perineum.—Pass the transverse part around the body above the iliac crests, and pin it in front; bring one of the tails over the dressing and up between the thigh and the genitals of one side, and the other tail over the dressing and up between the thigh and the genitals of the opposite side; secure these tails to the horizontal band.

Handkerchief Bandages.—Take unbleached muslin one yard square. The muslin folded once makes an *oblong* bandage; bringing its diagonal angles together makes a *triangle* bandage; a *cravat* is formed by folding a triangle bandage from summit to base; a *cord* is a twisted cravat. The triangle makes an admirable sling.

Fixed Dressings.—Plaster-of-Paris Bandage.—Cover the extremity with a cotton or flannel bandage or with a woollen stocking. Take a gauze roller infiltrated with plaster and place it endwise in a basin of tepid water, the water covering the plaster. When bubbles cease to arise, squeeze the bandage and apply it *without much tension*, smoothing out each turn with a moistened hand. As each

bandage is taken from the basin drop a fresh one into the water. Apply four thicknesses of bandage, and finish the dressing by sprinkling dry plaster over the bandage and smoothing it with wet hands. The ordinary plaster will set in from fifteen to thirty minutes. If it is desired to have it set more rapidly, put a tablespoonful of salt in each pint of water used; if to have it set more slowly, pour stale beer into the water. The plaster bandage is removed by sawing it down the front or by moistening with dilute hydrochloric acid and then cutting through the moistened line with a strong knife. Gigli has devised a mode of application which enables us to remove the dressing with ease. A layer of cotton is placed around the limb. A piece of parchment paper which has been wet and shaken out is placed over the cotton. A cord greased with vaselin is laid upon the paper in a position corresponding to the line we will wish to saw through the plaster. Apply the plaster bandage and see that the ends of the cord project beyond the bandage. When desiring to remove the bandage take a steel wire, make nicks on one side of it by means of a file, and attach the string to the wire. Pull the wire under the bandage. Attach each end of the wire to a wooden handle and saw through the plaster.[1]

Silicate-of-sodium Dressing.—Protect the part as is done for a plaster bandage. Bandage the limb *loosely* with an ordinary gauze bandage, paint this bandage with silicate of sodium, apply another bandage and paint it, and so on until six layers are applied. Gauze bandages soaked in silicate are better than ordinary bandages. Silicate dressings require from twelve to eighteen hours to dry, and they are removed by softening with warm water and then cutting.

XXXV. PLASTIC SURGERY.

Plastic surgery includes operations for the repair of deficiencies, for the replacement of lost parts, for the restoration of function in parts tied down by scars, and for the correction of disfiguring projections. A plastic operation can be successful after lupus only when the disease has been cured. It is useless to do a plastic operation during active syphilis, and a plastic operation for a syphilitic loss of substance is to be performed only after the patient has been thoroughly treated and the disease has been apparently cured. The first step of a plastic operation consists in making raw the surfaces which are to be brought together; the

[1] *La Semaine Méd.*, Nov. 3, 1895.

second step is the complete arrest of bleeding; the third step is the approximation of the surfaces without tension; the fourth step is to close any gap from which tissue may have been transplanted; and the final step is the application of the dressings.[1] The following are the methods used:[2]

Displacement is the method of stretching or of sliding: (1) approximation after freshening the edges (as in hare-lip; (2) sliding into position after transferring tension to other localities (linear incisions to allow of stretching of the skin over large wounds). *Interpolation* is the method of borrowing material from an adjacent or a distant region or from another person: (1) *transferring a flap with a pedicle*, which flap is put in place at once or is gradually gotten into place by a series of partial operations (as in rhinoplasty, when a flap is transverse from the forehead); (2) *transplanting without a pedicle*, which is performed by placing in position and by fixing there portions of tissue recently removed from the part, from another part of the same individual, or from a lower animal (as replacement of the button of bone after trephining, transplanting a piece of bone from a lower animal to remedy a bone-defect in a human being, or the grafting of a piece of nerve from a lower animal or an amputated human limb to remedy a loss of nerve in a human being in nerve-grafting, or skin-grafting). *Retrenchment* is the removal of redundant material and the production of cicatricial contraction.

Skin-grafting.—In **Reverdin's method** the surface to be grafted should possess healthy granulations which are at the skin-level. The grafts should, if possible, come from the person to be grafted.

Grafts may come from another person or from a lower animal, but such grafts are not apt to grow, and even when they do grow fail to furnish a secure cicatrix. Frog-skin furnishes unsatisfactory grafts. Arnot has employed the lining membrane of a hen's egg, cut in strips and applied upon the wound with the shell-surface uppermost. Lusk has blistered the skin with cantharides and grafted portions of the epidermis. In order to graft small fragments of human epithelium, cleanse the skin from which the grafts are to come, the ulcer, and the skin about it, and, if corrosive sublimate is used, wash it away with a stream of warm normal salt solution. Thrust a sewing-needle under the epidermis to raise it, cut off the graft with a pair of scissors, and place the cut surface of the graft upon the

[1] *American Text-book of Surgery.* [2] *Ibid.*

ulcer. After applying a number of grafts, place thin pieces of gutta-percha tissue over the grafts and extending on each side of the ulcer, and so placed as to have distinct intervals between them, the gaps permitting drainage. This tissue, after being asepticized, is moistened with warm normal salt solution ($\frac{7}{10}$ of 1 per cent.). Dress with a pad of aseptic gauze moistened with salt solution; place over this gauze a rubber-dam, and over the latter absorbent cotton and a bandage. In the case of children apply a light silicate bandage. Put the patient in bed. In forty-eight hours remove all the dressings except the gutta-percha tissue, irrigate with normal salt solution, and reapply the dressings. All signs of the grafts will often have disappeared. In a day or two, at the site of grafting, bluish-white spots should appear, which are islands of epidermis. Each graft is capable of forming about half an inch of cicatrix. Grafting also stimulates the edges of the ulcer to cicatrize and contract. At the end of seven days the special dressings can be dispensed with. The spot from which the grafts are taken is dressed antiseptically. Reverdin's method does not limit cicatricial contraction to any great degree, and the new skin is apt to break down.

Thiersch's Method.—Thoroughly asepticize the ulcer, the surrounding skin, and the site from which the graft is to come (the inner side of the arm or the thigh), and wash away the mercurial preparation with normal salt solution. Apply dressings wet with salt solution. On bringing the patient into the operating-room remove the dressings from the ulcer, scrape the ulcer and its edges, irrigate with salt solution, and compress to arrest hemorrhage. Grafts are then obtained by putting the prepared skin upon the stretch and cutting strips with a razor. While the razor is being used the part is constantly irrigated with salt solution. Mixter's apparatus enables one to perform this operation with great neatness and speed. This apparatus consists of a knife and an open square with sharp points on the under surface. The square is forced down upon the front of the thigh, the epidermis mounts up in the opening to above the level of the metal sides, and the grafts may be cut with ease. In Halsted's clinic the skin of the thigh is made tense by pressing upon it with a piece of asepticized wood, the wood is drawn slowly along, and is followed closely by the sharp catlin, with which the surgeon cuts long grafts. The grafts are pressed into place, and each graft overlaps a little the edges of the wound and the adjacent grafts. The skin-wound is

dressed antiseptically, and the grafted area is dressed as in Reverdin's method. Recently it has been suggested that a ring of aseptic gauze be made to encircle the limb below the grafted area, and another ring above the grafted area ; on these pads little strips of wood wrapped in aseptic gauze are so laid as to make a cage, and around this cage the dressings are applied (moist chamber plan).

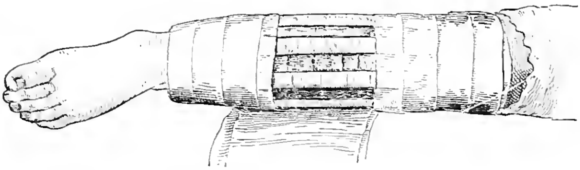


FIG. 371.—Mayer's dressing for Thiersch's method of skin-grafting (*Am. Text-Book of Surgery*.

Krause's Method.—In this method the grafts are composed of the entire thickness of the skin. The ulcer is extirpated and asepticized and bleeding is arrested. The flap is cut one-sixth larger than the surface to be covered. Fat is kept out of the graft. The bit of tissue is laid upon the ulcer, the edges of the graft being brought against the edges of the

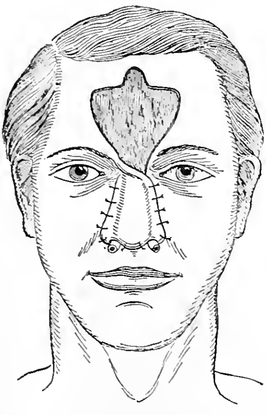


FIG. 372.—Indian method of rhinoplasty.

FIG. 373.—Italian method of rhinoplasty.

ulcer. It is not necessary to employ sutures. The part is dressed in a moist chamber. If the graft perishes, remove it.

Rhinoplasty.—The complete operation may be performed by transferring a flap from the forehead. This is known as the Indian operation. The edges of the defect are made raw. A model of the desired nose is made out of gutta-percha, and its outlines are marked upon the forehead, and the cut is made one-quarter of an inch outside of the outline so as to allow room for retraction. The flap is turned down and sutured in place (Fig. 372), care being taken not to cut off the blood-supply in the pedicle. Plugs of gauze or tubes are inserted to support the flap.

The complete operation can be performed by the Italian method (Tagliacotian method). In this method the flap is marked out on the arm, and is made twice the size of the desired nose, and the flap is left attached by a broad pedicle. The nasal defect is sewed, and the flap is sutured in place, the hand being held upon the head by a special apparatus (Fig. 373). The raw surface upon the arm is dressed. In about three weeks the flap is cut loose from the arm, and is pared and corrected as may be necessary.

The operations for harelip and cleft palate, and plastic operations on muscles, nerves, tendons, and bones, are considered in other portions of the work.

XXXVI. DISEASES AND INJURIES OF THE GENITO-URINARY ORGANS.

Hematuria.—By this term is meant the voiding of bloody urine or pure blood, the blood arising from any portion of the urinary apparatus, and the condition being a symptom and not a disease. Hematuria may be a symptom of disease or of injury of some part of the urinary system, of blood-disorganizations (purpura, scurvy, or variola), or of metallic poisoning (mercury, lead, or arsenic). The color of the urine in hematuria may be anything between a light red and a decided black, but these colors may be produced by agents other than blood. Senna and rhubarb make urine red; carbolic and salicylic acids, brown; beet-root and sorrel, the color of blood; methylene-blue, blue. In jaundice, melanosis, and splenic fever the urine becomes brown. Be sure that bloody urine in the female is not due to admixture with menstrual blood.

Tests for Blood.—**Spectroscope Test.**—Fresh urine diluted with water shows the two absorption-bands of oxyhemoglobin. The addition of ammonium sulphid causes the two bands to give place to the band of reduced hemo-

globin. If bloody urine stands for some time, the four bands of methemoglobin are discovered (v. Jaksch).

Heller's Test.—Add potassium hydrate to the urine, and boil: a red precipitate of earthy phosphates and hematin forms. Throw the precipitate upon a filter and treat with acetic acid: a red solution is produced, which soon fades.

Rosenthal's Test.—Take the precipitate from caustic potash, dry it, and test it for hematin; put some of the dry sediment on a slide, add a crystal of common salt, apply a cover-glass, and cause a few drops of glacial acetic acid to flow under the glass; warm, but do not boil. Teichmann's crystals will appear on cooling.

Struve's Test.—Test the urine with hydrate of potassium, and add acetic acid in excess: a dark precipitate forms, which will yield crystals of hematin when treated with sal ammoniac and glacial acetic acid.

Almen's Test.—Take 10 c.c. of urine, and pour upon its surface a mixture of equal parts of tincture of guaiac and old oil of turpentine: at the point of junction of this fluid with the urine there forms a white ring which turns blue.

Microscope Test.—The microscope shows numerous corpuscles except in a very alkaline urine, when but few corpuscles may be found.

In hemoglobinuria—a condition sometimes occurring in burns, acute maladies, and metallic poisoning—there is present blood-coloring matter, which is shown by Heller's test and by Almen's test. The spectroscope shows methemoglobin. The microscope shows no corpuscles or only a few, but discloses masses of pigment.

Bleeding from the Kidney-substance.—Bleeding from the *pelvis* of the kidney and from the *ureter* may be due to inflammation, congestion, contusion, stone, vicarious menstruation, hemorrhagic diathesis, powerful diuretics, fevers, purpura, tumors, catheterization of the bladder, etc. Blood is thoroughly mixed with the urine, and no sediment forms (smoky urine). The corpuscles are profoundly altered, are devoid of coloring-matter, and show pale-yellow rings. The severity of the hemorrhage is measured by the number of the corpuscles. Von Jaksch states that the diagnosis between renal and ureteral hemorrhage rests on the nature of the casts and the epithelium present. From the pelvis of the kidney and from the ureter come small epithelium, the cells from the superficial layers being polygonal or elliptical, those from the deeper layers being oval or irregular. In hemorrhage from the ureter the cells are few; in

hemorrhage from the pelvis they are plentiful and rest upon one another like "tiles on a roof" (v. Jaksch). Cells from the tubules of the kidney are small, granular, and polyhedral, have large nuclei, and are often so arranged as to form cylinders (epithelial casts). The urine of renal hemorrhage is apt to be acid unless alkalies have been administered, unless the bleeding has been severe, or unless pus is present in the urine. A very large renal hemorrhage may cause the passage of almost pure blood. In *renal* hematuria there are aching in the loin, numbness of the corresponding leg, and often renal colic. The use of the cystoscope enables the surgeon to determine if the hemorrhage is vesical or renal, and if it comes from one or both kidneys. If the bladder-fluid is kept clear, the blood can be seen flowing out of the ureter of the damaged organ.

Catheterization of the ureters may give valuable information. Kelly performs this operation in women with the

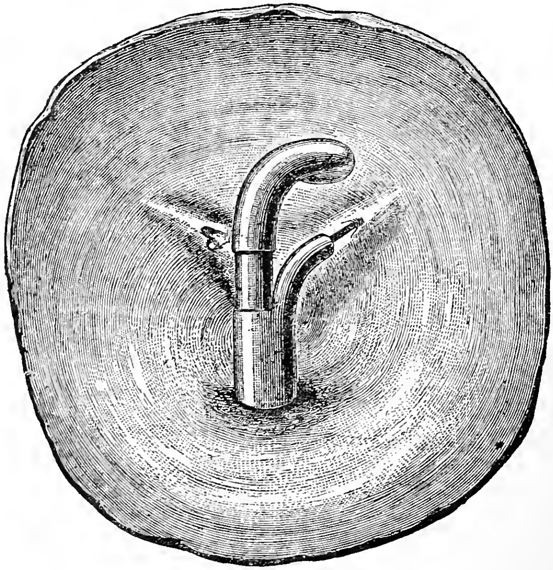


FIG. 374.—Nitze's instrument in use (*Berl. klin. Wochen.*).

greatest ease. Aseptic precautions are observed. A speculum is inserted, the orifice of the ureter is cleansed with a bit of cotton, and the catheter is inserted, and the urine is collected in a sterile test-tube. Kelly's catheter is of flexible silk, 30 cm. in length, 2 mm. in diameter, with a blunt coni-

cal end and an oval eye. The catheter is pushed into the ureter 12 or 15 mm. The rate of flow in a given time proves the competence of the kidney. The male ureter can be catheterized by means of the instrument of Nitze (Fig. 374).

Kelly has recently catheterized the ureter in a man by inserting a straight speculum, placing the patient in the knee-chest position to inflate the bladder with air, and introducing a metallic catheter.

Professor Harris, of Chicago, has devised an excellent instrument (Fig. 375) which greatly simplifies the problem of obtaining unmixed urine from each ureter. The double catheter is passed into the bladder. The lever is inserted in the rectum of the male and the vagina of the female. The lever is fastened to the perforated frame from the double catheter. The double catheter is now opened in the bladder, and the blades of the instrument are held in position by a spring. The end of the lever in the vagina or rectum humps

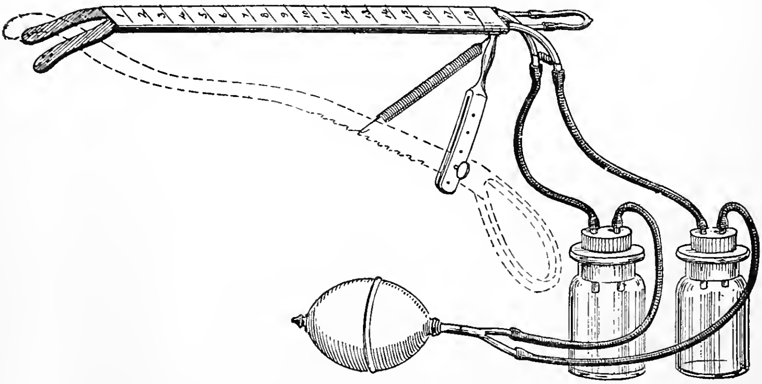


FIG. 375.—Harris's instrument fitted for use.

up the floor of the bladder between the separated ends of the divided catheter, and forms a longitudinal septum or water-shed between the ureteral orifices. The end of each catheter lies in the bottom of a pocket in the side of the water-shed. "By producing a very slight exhaustion of the air in the vials by means of the bulb, the urine, as fast as it escapes from the ureters, drops directly into the ends of the catheters and flows at once into the vials, right and left respectively."[1]

In using this instrument, place the patient flat on his back upon a table, the thighs and legs being flexed, and the feet, hips, and head being on the same level. Irrigate the bladder

[1] M. I. Harris, in *Medicine*, April, 1898.

thoroughly with sterile water, and have 150 c.c. of fluid in the bladder when the blades are opened. Leave the instrument in place for thirty minutes. It is rarely necessary to give an anesthetic. In some cases cocaine must be used, and in some cases of painful cystitis ether should be given. Harris says the instrument should not be used if there is a growth of the bladdder that bleeds easily, if the bladder is contracted, or if there is a very large prostate or a vesical stone.[1]

Vesical hemorrhage, including hemorrhage from the prostate, may follow the relief of retention of urine, may be due to stone, inflammation, tumor, etc., or may arise from traumatisms, instrumental or otherwise. The color of the urine is usually bright red, but if long retained in the bladder it becomes black and often tarry. The reaction is alkaline. The clots, when floated out, are large and without definite shape. In micturition the urine is clear or only a little colored at the beginning, but becomes darker and darker as micturition ends, at which time the flow may consist of almost pure blood. In very small vesical hemorrhages the urine may be smoky. Crystals of triple phosphate indicate bladder disorder. The microscope shows colorless and swollen corpuscles and many polygonal cells. Symptoms of bladder mischief usually exist, but cystoscopic examinations or exploratory suprapubic cystotomy may be demanded for the diagnosis.

Urethral Hemorrhage.—In urethral bleeding blood comes independently of micturition, or blood comes out first and is followed by clear urine. Urethral hemorrhage arises from an acute urethritis, from an inflamed stricture, from the passage of an instrument, or from some other traumatism.

The source of urethral hemorrhage can be ascertained by the use of the endoscope.

Pain in Genito-urinary Diseases.—Pain as a symptom of genito-urinary disease may be found at some point distant from the seat of lesion. A stone in the bladder causes pain in the head of the penis just back of the meatus; stone in the kidney induces pain in the loin, the groin, the thigh, and the testicle; inflammation of the testicle causes pain in the line of the cord in the groin. In other cases of genito-urinary disease pain is felt at the seat of lesion, as in urethritis and prostatitis. Pain felt before micturition, and being relieved by the act, is found in cystitis and in retention of urine. Pain is felt during micturition in inflammation of the bladder, prostate, and urethra, and in the passage of

[1] *Jour. Cutan. and Gen.-Urin. Dis.*, May, 1899.

gravel or stone. Pain which is acute at the end of micturition is noted in stone in the bladder, in inflammation of the neck of the bladder, and in inflammation of the prostate gland. The pain of stone in the bladder, it may be observed, is ameliorated by rest and is aggravated by exercise. The pain of acute prostatitis is intensified by defecation.

Frequency of Micturition. — Frequent micturition arises from irritation of the sensory nerves, from phimosis, contracted meatus, inflammations, very acid urine, calculi, urethral stricture, and hyperesthesia of the urethra. Frequency of micturition may be due to spinal irritability from concussion or from sexual excess, from contraction of the bladder rendering the viscus unable to hold much, from worry, anxiety, fear, or from excessive urinary secretion, as in diabetes or in the first stage of contracted kidney. Frequent micturition exists in obstruction by enlarged prostate and in atony of the bladder-walls. Hypersecretion of urine plus bladder intolerance is known as "nervousness," and is found in hysteria. Frequency of micturition increased by *movement* is observed in stone and tumor of the bladder; increased by *rest*, is found in enlarged prostate and atony of the muscular walls of the viscus. Frequency of micturition with diminution of stream-caliber suggests a constriction of the urethral diameter; frequency of micturition with diminished force suggests a posterior stricture, enlarged prostate, or bladder atony. Slowness of micturition hints at enlarged prostate, atony, or urethral stricture.

Thompson's diagnostic questions are as follows:

"1. Have you any, and, if so, what, frequency in passing water? Is frequency more manifest during the night or the day? Is frequency more manifest during motion or rest? Does any other circumstance affect it?

"2. Is there pain on passing urine, and, if so, is it before, during, or after the act? What is its character—acute, smarting, dull, transitory, or continuous? What is its seat? Is it felt at other times, and is it produced or intensified by sudden movements?

"3. What is the character of the stream? Is it small or large; twisted or irregular; strong or weak; continuous, remitting, or intermitting? Does it come by the meatus, or partly or entirely through fistulæ?

"4. Is the character of the urine altered? What is its appearance, color, odor, reaction, and specific gravity? Is it clear or turbid, and, if turbid, is it so at the time of passing? Does it vary in quantity? Are the normal constitu-

ents increased or diminished? Does it contain abnormal elements, as albumin or sugar? What inorganic deposits are found? What organic materials are met with?

"5. Has the urine ever contained blood? If so, was the color brown or bright red; were the blood and urine thoroughly mixed; was the blood passed at the end or at the beginning of micturition, or did it come only with the last drops of urine; or was it passed independently of micturition?

"6. Inquire as to pain in the back, loins, and hips, permanent or transitory, and for the occurrence of severe paroxysms of pain in these regions."

Diseases and Injuries of the Kidney and Ureter.

Tumors of the Kidney.—Tumors, innocent or malignant, may arise in the kidney. Among the innocent tumors are fibroma, lipoma, angeioma, and adenoma. A malignant tumor may be either sarcoma or carcinoma. Sarcoma is most common in the young, and may reach an enormous size. A malignant tumor of the kidney produces hematuria, the urine often containing blood-casts of the ureter, kidney, and pelvis (Osler), and sometimes, though rarely, characteristic cells. Pain is often present in the loin and thigh, and there may be colic-like attacks when clots are passing through the ureter. Emaciation is rapid and pronounced. A tumor can usually be detected. The only possible treatment is early nephrectomy. In some few cases an innocent tumor can be removed by a partial nephrectomy. A malignant tumor requires a complete nephrectomy. In making a diagnosis of renal tumor use the cystoscope. If blood is coming from a ureter, note if it is from only one or from both. Blood from both would contraindicate nephrectomy. Before removing a kidney it is well to be sure that the patient is possessed of two kidneys. Note if urine flows from each ureter, or, if uncertain, catheterize the ureters or have a specialist do it.

Nephroptosis, or Mobile Kidney.—There are two forms of this condition: (1) *movable kidney*, which is an organ freely moving back of the peritoneum, either within the cavity of its fibrofatty capsule or entirely without its capsule (this condition is acquired); and (2) *floating* or *wandering kidney*, an organ having a mesonephron and lying within the peritoneal cavity (this rare condition is always congenital). Keen states that there may be drawn a clear theoretical distinction between movable and floating kidney, but practically

there is no rigid line of demarcation, as a movable kidney may have as large a range of movement as a floating kidney. When a movable kidney becomes fixed in an abnormal situation the organ is spoken of as *dislocated*. The organ may drop below the brim of the pelvis, may cross the vertebral column, or may reach the anterior abdominal wall. Women more often suffer from movable kidney than do men, and it is found in the great majority of cases upon the right side. Floating kidney is always congenital. Among the assigned causes of the movable condition are to be named traumatisms, strains, abdominal-wall laxity from pregnancy, absorption of peritoneal fat from wasting disease (Edebohls), and tight lacing. The condition is often associated with ptosis of the other abdominal viscera (enteroptosis, gastroptosis, etc.).

Symptoms of Both Forms.—There may be no discomfort whatever, or the patient may be a confirmed invalid. The usual symptoms are epigastric pain (just to the left of the middle line), which disappears when the kidney is replaced, dragging pain in the loin, and paroxysms like nephritic colic. There is a sense of a moving body in the abdomen, and the patient has aggravated indigestion, often accompanied by vomiting. Constipation is the rule, and violent attacks of cardiac palpitation are common. Most subjects of this kidney-mobility are extremely nervous, many of them hysterical or hypochondriacal. In women the sexual organs are almost invariably deranged, and menstruation aggravates the pain and discomfort. All the symptoms are intensified by exertion and are modified by rest. The urine is normal. The proof of the existence of movable kidney is the finding of a tumor (movable on respiration, change of position, and palpation) shaped like that organ, pressure upon which occasions no sensation or causes pain or a sickening feeling. A "lumbar recess" (Morris) may be found, and percussion over the loin gives resonance. In some cases a movable kidney can be readily detected when the patient stands up, but is hard to find when he is recumbent. Franks's method of examination is very satisfactory. The patient is placed recumbent. If dealing with a right kidney, the surgeon stands to the right side and pushes four fingers of his left hand in the loin below the twelfth rib, and rests the thumb lightly in front just below the ribs. The patient takes a full breath and holds it a moment, and just before he empties his lungs the surgeon presses his thumb up deeply below the ribs. During expiration the thumb follows the liver, and the fingers press toward the front. If with the right

hand the kidney can be felt entirely below the left hand, the case is one of movable kidney. If such a condition is detected, press hard with the right hand, and gradually loosen the grasp of the left hand, and the kidney will slip between the fingers and ascend. A normally mobile kidney descends so that its lower half can be felt, but it moves back during expiration.[1] A movable kidney must not be mistaken for a distended gall-bladder, a tumor of the mesentery, stomach, or omentum, a phantom tumor, an ovarian tumor, or a cancer of the pancreas. Sometimes a movable kidney endangers life, rupture of the kidney or twisting or rupture of the ureter occurring, the ultimate cause of death being albuminuria, uremia, or hydronephrosis.

Treatment.—Mobile kidney is treated as follows: (1) *The rest-treatment of Weir Mitchell* may be tried; it often markedly mitigates the symptoms, but does not seem to cure. (2) *Bandage and pad* should always be tried, using the pad of Dunning or Newman: this will cure not a few cases. Edebohls uses only a bandage of elastic webbing or a well-fitting corset. (3) *Nephrorrhaphy* or nephropexy is the operation employed in many instances (page 963). It is the author's experience that if the patient has had marked nervous symptoms for a long time, nephrorrhaphy will rarely cause them to permanently pass away, even though the kidney remains firmly anchored. (4) *Nephrectomy* is necessary only in very rare cases; it may be done for dislocated kidney, when kidney disease exists, or when nephrorrhaphy has failed in a case of great severity.

Injuries of the Kidney.—**Laceration** or **rupture** is caused by falls and by blows upon the back or the belly. The blood may or may not extravasate into surrounding structures. The *symptoms* are pain in the loin, shooting into the testicle or the thigh; frequent and painful passage of bloody urine or suppression of urine; the loin is full and is dull on percussion, and collapse or evidences of internal hemorrhage exist. Bloody urine is not proof of renal injury, and kidney damage may occur without hematuria. The use of the cystoscope or catheterization of the ureters will show from which kidney blood comes.

Treatment.—If the shock is profound with increasing fulness of the loin, whether hematuria exists or not, or if blood comes profusely from the urethra, make an exploratory lumbar incision and stop the bleeding by packing, or by a purse-string suture (Figs. 376, 377), or, if necessary, perform partial, or even complete, nephrectomy. Ordinarily the cases

[1] *British Med. Journ.*, Oct. 12, 1895.

are treated by rest in bed and by feeding with liquid food or by nutritive enemata to prevent vomiting. Opium, tannic acid, or gallic acid may be used. Apply ice-bags to the loin and the

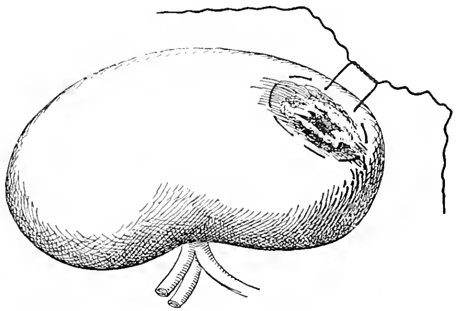


FIG. 376.—"Purse-string" suture applied to a perforation (after Schachner).

side of the abdomen, and after bleeding ceases strap the loin and apply a binder. If large blood-clots cause pain or retention, introduce a catheter and inject the bladder with boric

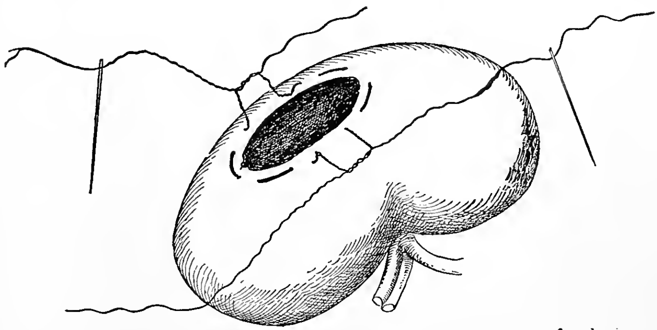


FIG. 377.—Showing the application of a double "purse-string" suture for the arrest of hemorrhage in large wound (after Schachner).

acid, or use the tube and evacuator of a Bigelow apparatus. If this procedure fails, open the bladder by a suprapubic incision and drain.

Perforating wounds of the kidney, if purely posterior, do not involve the peritoneum; if anterior, they do. The *symptoms* are escape of blood and urine by the wound; hematuria is usual, but not invariable; pain as in rupture; the patient may be unable to micturate; and nausea, vomiting, and constitutional signs of hemorrhage exist. Traumatic peritonitis, perinephric abscess, or general sepsis may ensue. Confirm

the diagnosis by exploration with the finger. Extraperitoneal injuries give a good, and intraperitoneal a bad, prognosis.

Treatment.—If the wound in perforated kidney is extraperitoneal, enlarge it to permit of drainage, and arrest hemorrhage by packing and hot water, or by a purse-string suture (Figs. 376, 377). Asepticize the wound, insert a drainage-tube down to the kidney, dress often with bichlorid gauze, keep the patient in bed on a low diet, and give gallic acid and opium. In some cases nephrectomy, partial or complete, will be required. In intraperitoneal wounds perform an abdominal section and remove the damaged organ (see Nephrectomy).

Wounds of the Ureter.—The ureter may be wounded by the surgeon accidentally during the performance of an abdominal operation, or it may be wounded intentionally, as in Morris's cases, in which a malignant growth was incorporated with the ureter. Wounds of the ureter as a result of accidental violence are almost invariably associated with other serious injuries.

Treatment.—Remember that the upper three-fourths of the ureter can be reached by an extraperitoneal incision, which is a prolongation of the incision for lumbar nephrectomy, running from the twelfth rib downward, and forward to one inch anterior to the spine of the ilium, and then parallel to Poupart's ligament until a point is reached above its middle (Fenger). The lower one-fourth of the ureter can be reached by abdominal section or by sacral resection (Cabot). If it seems probable that the ureter is wounded or ruptured explore, and if this is found to be the case endeavor to restore the continuity of the tube (Fenger). If the ureter is cut across near the bladder, implant the proximal end into the bladder (Van Hook, Penrose, Kelly). If it is cut above the bladder portion, perform lateral implantation by Van Hook's method (page 965).

A longitudinal wound of the urethra inflicted during an abdominal operation should be sutured, but if the duct cannot be readily reached, simply make a posterior incision and drain, as the longitudinal wound will heal by granulation if no sutures are inserted (Van Hook).

Renal Calculus.—A stone in the kidney is formed by the precipitation of urinary salts into the renal epithelial cells and the gluing together of these salts and cells by material from mucus or blood-clot, this mass serving as a nucleus on which accretion takes place. Most calculi escape when

small as *gravel.* The **cause** is a highly acid urine, which induces catarrh of the renal tubes. This high concentration of urine is favored by a sedentary life, by the ingestion of much alcohol or nitrogenous food, by constipation, by an inactive skin, and by a torpid liver. The children of poverty are liable to calculi because of the use of unsuitable foods and the formation of great amounts of nitrogenous waste. Males more often suffer than do females, certain locations favor the development of the malady, and a family tendency sometimes exists.

Symptoms.—The symptoms of stone in the kidney may not appear for years, but generally they are manifested early. The patient usually complains of pain in the loin, and sometimes of pain in the iliac region. Deep percussion over the kidney causes pain in the loin, even when pressure is painless (Jordan Lloyd's symptom). Pain is aggravated by exercise. The urine is often somewhat albuminous, and may from time to time contain blood. Frequency of micturition is noted during the day, but not at night. The urine may be purulent. Nephritic colic is due to the washing of a calculus into the orifice of the ureter, which it blocks, tears, or distends. The pain is either sudden or gradual in onset, is fearful in intensity, and runs from the lumbar region down the corresponding thigh and spermatic cord (the testicle being retracted) and into the abdomen and shoulder-blade. There are nausea, vomiting, collapse, sometimes unconsciousness or convulsions. Frequent attempts at making water are productive of pain, but of little urine. The urine is usually, but not always, smoky from blood. After a time the pain vanishes, the stone having passed into the bladder or having fallen back into the pelvis of the kidney. A calculus retained in the kidney eventually excites pyelitis. There is pus in the urine, and soreness or pain in the loin exists. Kelly says: even if pus is found we are not always sure from which kidney it came. Pain or swelling may point to one side, but we are not sure that the other organ is not also affected. If able to pass the renal catheter into one ureter, attach a syringe, and by making suction draw out any pus which may be present. In renal calculi cases this fluid is apt to contain fragments of uric acid. By using a renal bougie coated with dental wax it may be possible to make scratches on the instrument when it comes in contact with a concretion.[1] Slight attacks of colic occur from the passage of small stones or of plugs of mucus. When a stone is im-

[1] Howard Kelly, in *Med. News*, Nov. 30, 1895.

pacted in the pelvis the point of greatest tenderness on pressure is below the last rib, by the edge of the erector spinæ muscle. When a stone is impacted in the ureter the point of greatest tenderness is either in the loin below the level of the kidney or in the iliac region (Perkins). In many cases a stone in the kidney or ureter can be skiagraphed. If a stone partly obstructs the ureter, the urine is pale and of low specific gravity and free from albumin. Jordan Lloyd says that impaction near the bladder causes symptoms similar to stone in the bladder. Impaction near the kidney is accompanied by hematuria and pyuria. In stone in the ureter prodding the loin does not cause pain (Lloyd). Entire obstruction of the ureter induces hydronephrosis or pyonephrosis. Nephrolithiasis may cause death by exhaustion, by sepsis, by rupture of a hydronephrosis, or by amyloid degeneration.

Treatment.—For the gravel of the uric-acid diathesis use alkalies, especially the liquor potassii citratis, and reduce the amount of nitrogen in the diet to a minimum, at the same time washing out the organs by copious draughts of Poland water or Londonderry lithia. Piperazin, in doses of gr. v to gr. viij three times a day, is highly commended. Exercise is to be insisted on. When gravel is phosphatic order strychnin, the mineral acids, and rest at the seaside. When oxalate of lime is found restrict diet, use the mineral acids, recommend travel or rest amid new surroundings, and give an occasional course of sodii phosphas, ʒss three times a day, drunk in Buffalo lithia water. Nephritic colic is relieved by hypodermatic injection of morphin and atropin, the hot bath, diluent drinks, or the inhalation of ether. After the attack wash out the bladder with an evacuator. If a stone impacts in the ureter, perform the operation of ureterolithotomy. The diagnosis of this impaction is often possible only by exploratory laparotomy. If the symptoms point to stone in the kidney, medical treatment having been used without avail, and there being no evidence of organic disease of the other kidney, make an exploratory lumbar incision; feel the surface of the kidney with the finger, sound the inside of the organ with a needle, and if a stone is detected, incise the kidney and remove the stone. Keen is of the opinion that operation should not be performed if the urea is below 1 per cent. If, after nephrolithotomy, suppression of urine occurs, cut into the other kidney, as in half of all cases a stone will be found lodged there.

Abscess of the kidney is caused by traumatism, by

calculus, by stricture of the urethra, by disease of the bladder, by the union of miliary abscesses, or by pyemia.

The **symptoms** are pus in the urine (this is usual, but not invariable), hematuria in traumatic cases, and pain running into the groin. The urine is usually alkaline. Constitutional symptoms of suppuration exist, the fever being far higher than that usually met with in renal tuberculosis. The bladder should be examined with a cystoscope to determine that the turbid urine flows from a ureter and to identify the diseased side. It is well, if possible, to catheterize the ureters.

The **treatment** in the early stage is rest, morphin, purgation, anodynes, and ice-bags to the loin, followed in forty-eight hours by hot fomentations. When the diagnosis is clear incise the loin, open and stitch the kidney to the abdominal wall, or, if the organ be badly damaged, remove it.

Pyelitis and **pyelonephritis,** which usually affect only one gland, are caused by urethral stricture, by stopping of the ureter by blood-clot, by vesical paralysis, by stone in the bladder or in the kidney, and by enlargement of the prostate gland.

Symptoms.—A patient who has, or who has had, retention of urine develops high fever, often preceded by a chill; headache, stupor, and dry tongue are noted. Unlike acute Bright's disease, there is neither edema nor dry skin, convulsions do not occur, and the urine is plentiful and contains pus and, but rarely, blood. The **prognosis** is very bad.

The **treatment** is to remove the obstruction if possible. If the urine be acid, give liquor potassii citratis; if alkaline, give benzoic acid. Gallic acid, eucalyptol, and small doses of copaiba or cubebs are recommended. Venice turpentine, camphor, and opium may be given in pill-form. Quinin is used to stimulate the patient and to lower fever. The bladder is to be washed out every day with boric-acid solution (gr. iij–℥j). Cups, dry or moist, and hot sand-bags or bran-bags are to be applied to the loin. Alcohol may be sparingly administered. Urotropin has lately been used with benefit.

Perinephritis is an inflammation of the perinephric fatty tissue produced by cold, febrile disease, slight traumatism, or spread of inflammation from another part.

The **symptoms** of this condition are rigidity of the spine, the inclination being toward the affected side, flexion of the thigh, and often pain in the knee. The symptoms resemble those of hip-joint disease in the second stage. Suppuration may or may not take place.

The **treatment** is wet cups to the loin, ice-bags to the loin, rest, purgation by salines, morphin for pain, and, after the acute stage, potassium iodid internally and ichthyol locally.

Perinephric Abscesses.—An abscess in the perinephric fat is known as a perinephric or perirenal abscess. *Primary abscess* is caused by chills, acute febrile disturbances, or by pus flowing from some other part, as the spine. Slight traumatisms by producing hemorrhage make the perinephric region a point of least resistance, and lead to abscess. The causative injury may be produced by digging, stamping, coughing, falling, carrying a burden, lifting a weight, riding on a horse or in a jolting wagon. *Consecutive abscess* is secondary to kidney inflammation, suppuration, calculus, tuberculosis, or cyst. In the consecutive form the symptoms may be masked by the malady to which perinephric abscess is secondary. As a rule, in perinephric abscess there are found the constitutional symptoms of suppuration. The local symptoms are a deep aching and paroxysmal pain intensified by lumbar pressure. Edema of the corresponding foot and lameness are not unusual. The thigh is often drawn up. Edema of the skin is usual, but fluctuation is rare. The exploratory incision will settle a doubtful diagnosis.

The **treatment** is to lay open the abscess, wash it out, and drain.

Hydronephrosis is a condition of the kidney in which an impediment to the outflow of urine is caused by obstruction in the ureter, the bladder, or the urethra, the calyces of the kidney becoming over-distended with urine and the glandular tissue being absorbed by pressure. It has been asserted by Albanan that secretion of urine ceases in a kidney whose ureter is blocked, distention being due purely to congestion. This condition may be congenital, due usually to twisting of the ureter or to valve-formation obstructing the ureter at its point of junction with the pelvis of the kidney, the valve being produced because the ureter passes into the kidney pelvis at an unnatural angle. Occasionally imperforate meatus produces hydronephrosis of both kidneys. The **causes** of the acquired form are the pressure of pelvic growths or pregnancy, inflammation or tumor of the bladder, stone in the bladder, kidney, or ureter, twisting or kinking of the ureter of a movable kidney, enlargement of the prostate gland, and stricture of the urethra. This acquired hydronephrosis may involve both kidneys, all of one kidney, or only a part of a single gland.

Symptoms.—Hydronephrosis is most frequent in females. When tumor is absent there may be no symptoms, or there may be pain in the back and abdomen, frequent micturition, a persistent or intermittent diminution in urine, or even occasional anuria. A tumor may be found in the loin, which growth is dull on percussion and may come and go, a large urinary flow occasionally occurring when it disappears. Hydronephrosis may last a long while if only one kidney be involved, but death is not far distant if both glands suffer. Death occurs from anemia, from pressure on adjacent organs, or from rupture into the peritoneal cavity. The diagnosis is aided by the use of the cystoscope and by catheterizing the ureters.

Treatment by aspiration may cure, but the operation may have to be done repeatedly. Tapping on the left side is performed just below the last intercostal space; on the right side the tap is made midway between the last rib and the crest of the ilium. Some few cases have been cured by catheterizing the ureter (Pawlik). The proper operation in most cases is nephrotomy, stitching the edges of the cut kidney to the surface. After the kidney has been opened explore the ureter by means of a uterine sound or an elastic bougie. A healthy ureter will permit the passage of an instrument of the size of from No. 9 to 12 (Fenger). If the opening of the ureter into the pelvis cannot be found, open the pelvis or open the ureter. A valve is slit longitudinally (Fenger). If a permanent suppurating fistula ensues or if the organ is found extensively damaged, nephrectomy is to be performed, provided the other kidney is in reasonably good condition.

Pyonephrosis, or **surgical kidney,** is a condition in which the pelvis and the calyces of the kidney are distended with pus or with pus and urine. The whole kidney may be destroyed. This condition has the same causes as has hydronephrosis, for it is in reality usually an infected hydronephrosis. In some cases the inaugural malady is pyelitis, which causes blocking of a ureter. Watson of Boston has reported two cases associated with obliteration of the ureter by a mass of fibrous tissue (stricture of the ureter).

Symptoms.—At first the symptoms are those due to the obstructing cause, plus pyelitis. Pus may appear in the urine in incomplete obstruction, or it may intermittently come and go. Constitutional symptoms of suppuration are soon manifest. A tumor may appear in the loin, like the

tumor of hydronephrosis. If only one kidney is involved, and if the disease is due to blocking of a ureter, recovery is to be expected. The diagnosis is rendered more certain by the use of the cystoscope and by catheterizing the ureters.

The **treatment** in the early stages comprises removal, if possible, of the cause of obstruction and the employment of measures directed to the cure of the pyelitis. If obstruction is not complete, palliative measures may be employed for the tumor. If fever is continued, if there is great visceral derangement, if pain is severe and constant, and if the tumor continually grows, perform a nephrotomy, stitching the organ to the surface if possible, or removing it if it is hopelessly disorganized.

Chronic Tuberculosis of the Kidney.—This condition may begin in one kidney, no other dépôt of infection existing in the body. In such cases the organisms were deposited from the blood. The other kidney is usually involved subsequently, the process in the first kidney affecting the bladder and secondarily the other kidney. The important point is that tuberculosis of the kidney arising in this manner is at first a unilateral disease.

Tuberculosis of the kidney may arise secondarily to tuberculosis of the prostate and bladder. In such a condition the kidney disease is usually bilateral.

Symptoms.—Renal tuberculosis of arterial origin may exhibit no symptoms until the disease is far advanced. Renal tuberculosis secondary to disease of the bladder or prostate always presents symptoms.[1] A very common symptom is the sudden onset of polyuria and frequent micturition. The patient is annoyed day and night, and in some cases micturition is distinctly painful. Paroxysms of renal pain are not unusual. The urine is acid, and may contain pus or blood. Tubercle bacilli may be found in the urine or in the sediment, but they may be absent. Repeated examinations should be made before it can be stated certainly that bacilli are absent. The presence of bacilli proves the diagnosis, but their absence does not negative it (Willy Meyer). If bacilli are not found, inject some of the urinary sediment into a guinea-pig, and note if tuberculosis arises in the animal. The urine may or may not be albuminous.

Czerny has shown that in cases of tubercular kidney in which bacilli are not found in the urine, the administration of tuberculin will cause great numbers to appear. This agent

[1] F. Tilden Brown, *New York Med. Jour.*, April 10, 1897.

will also cause a marked febrile reaction if tuberculosis exists. In spite of the important diagnostic result of a dose of tuberculin it is scarcely wise to give it, as it may cause disseminated tuberculosis.

In many cases the kidney is obviously enlarged, and this area is frequently tender and occasionally painful. The patient loses flesh, and there is nocturnal fever followed by sweating. The use of the cystoscope furnishes important information. It shows from which ureter turbid urine is coming. Catheterization of the ureters should be practised by some one who is accustomed to employ it. Always examine carefully to determine if one or both kidneys are involved, if the bladder is diseased, and if the prostate gland or seminal vesicles are tubercular.

Treatment.—Nephrectomy is not justifiable in the very beginning of a case, because such a case may attain to a cure by a combination of medical and hygienic treatment, and the weakening effect of the operation of nephrectomy may cause the other kidney to rapidly develop tuberculosis. Tell such a patient to lead an outdoor life. Brown recommends camp-life in the Adirondacks during the summer, and sends such patients south during the winter. If a patient cannot go to another climate, urge upon him the necessity of being much out of doors. Insist upon the taking of plenty of nutritious food. Order courses of creasote or guaiacol carbonate.

If the kidney is markedly enlarged, if there is profuse hematuria, if the fever is high and persistent, if only one kidney is involved, and if the bladder and prostate are free from disease, perform nephrectomy. In cases with involvement of the other kidney or of the genito-urinary tract lower down, nephrectomy is rarely justifiable, although nephrotomy for drainage may greatly benefit the patient for a time.

Operations on the Kidney and Ureter.—**Nephrotomy** means incision of a kidney, but the term is sometimes, though wrongly applied, to the exploratory exposure of the kidney without incision. The *instruments* required are scalpels, a blunt-pointed bistoury, dissecting-forceps, toothed forceps, a grooved director, hemostatic forceps, spatulæ, metal retractors, a fountain syringe, an Allis dissector, Hagedorn needles, and an Abbe needle-holder. If looking for a stone, have a large harelip-pin to sound with, forceps and a scoop to remove the stone, and a periosteum-elevator to scrape away adherent calculi. The patient lies upon the sound side, a sand-pillow being placed under the loin. The *incision* is

made half an inch below the last rib and close to the outer border of the erector spinæ mass, and runs obliquely downward and forward toward the iliac crest for three inches, the incision being enlarged later if required. Divide the skin, the superficial fascia, the fat, the external oblique, the posterior border of the internal oblique, and the outer edge of the latissimus dorsi. This incision exposes the lumbar fascia. Push aside the last dorsal nerve and incise the lumbar fascia, when the perirenal fat will bulge into the wound. Two distinct layers of fat exist. Tear this fat through with dissecting-forceps or with an Allis dissector to expose the kidney, which can now be opened while it is forced into the wound by the hand of an assistant making abdominal pressure.

Kocher's incision for nephrotomy is begun in the angle between the sacrolumbalis muscle and the twelfth rib, and is carried downward, forward, and outward to the axillary line. This incision divides the skin, subcutaneous tissues, lumbar fascia, the latissimus dorsi, and the serratus posticus inferior muscles.

Edebohls's method enables the surgeon to most thoroughly explore the kidney, because this organ is brought outside of the body. The patient lies prone, with a large cylindrical inflated rubber pad beneath his abdomen. A vertical incision is made close to the border of the erector spinæ muscle, from just below the last rib to just above the iliac crest. The fatty capsule is *well separated* from the kidney front and back. The patient is pulled by the legs toward the foot of the table, the pad remaining stationary. This change of position brings the pad beneath the chest, abdominal respiration takes place, the kidney is forced out of the wound, and can be thoroughly examined.

Nephrolithotomy.—In this operation the incision is the same as in nephrotomy. If the kidney is not much enlarged, it can be brought out by Edebohls's method. Feel the kidney for a stone, or, if this procedure fails, explore with a needle or a pin. If no stone is found, open the pelvis, let an assistant grasp the pedicle with his fingers or with a pair of forceps, each blade of which is covered with a bit of rubber tube, while the surgeon opens into and explores with the finger. If a stone is detected, open the kidney-tissue, loosen the calculus with the nail, and remove it with the finger, with a scoop, or with forceps. After removing the stone suture the incision with catgut, and release the pressure on the pedicle. Hemorrhage will rarely occur. If in spite of this plan bleeding occurs, take out the stitches and apply pressure and hot

water, or in some cases plug with iodoform gauze for twenty-four hours. When hemorrhage ceases put a large drainage-tube down to the kidney. Close the wound in the muscles and integument and dress antiseptically. The dressings must be changed frequently and the tube should be shortened daily.

Nephrectomy is the removal of a kidney. There are two methods of nephrectomy, the *lumbar* and the *abdominal*. Before performing nephrectomy ascertain the competence of the kidneys. If at least 1 per cent. of urea is not being excreted, it is very unsafe to operate. Be sure the patient possesses two kidneys. Examination of the bladder by a cystoscope will show the ureteral orifices, a strong indication that both kidneys are present. Nevertheless, when we reflect that a horseshoe kidney has two ureters the proof is not absolute. Catheterization of the ureters is advisable if it can be performed, but it will probably require a specialist to perform it. Proof absolute of the presence of two kidneys consists in feeling both of them. If in doubt as to the question, and if uncertain as to the competence of the organ which is to be left, feel each kidney during the operation and before removing either, or perform a preliminary exploratory laparotomy.

Lumbar Nephrectomy.—The instruments required for this operation are scalpels, a blunt-pointed bistoury, forceps as used in the preceding operation, a clamp, retractors, spatulæ, blunt hooks, an aneurysm-needle, a pedicle-needle, a grooved director, stout silk, an Allis dissector, sharp spoons, and a Paquelin cautery. The patient is placed on the sound side and a pillow is placed under the loin. Several incisions have been proposed. In many cases the oblique incision is first made to permit of exploration. This incision is begun half an inch below the last rib and by the edge of the erector spinæ muscle, and is carried downward and forward toward the iliac crest. In some cases a kidney can be removed through this cut. In other cases the cut must be enlarged. It can be enlarged by extending the cut downward. Morris enlarges it by adding to it a vertical incision, which begins one inch below the origin of the oblique cut. König's incision for nephrectomy consists of a vertical cut by the edge of the erector spinæ, carried almost to the iliac crest, from which point it is curved forward toward the umbilicus, and is carried to or even through the rectus muscle. After thorough exposure lift the kidney, and separate it from the peritoneum, if possible, with the

finger; clamp the pedicle; pass an armed aneurysm-needle between the vessels of the pedicle; ligate in two places; cut between the threads; and arrest hemorrhage by ligature or by the cautery. If the ureter be healthy, ligate it with silk and drop it back; if it be foul and purulent, scrape it with a spoon, wash it with corrosive sublimate, and touch it with pure carbolic acid, and then either ligate it and drop it back or sew it into the wound. If hemorrhage persists from the wound, plug with gauze. Put in a drainage-tube and close the wound. If the peritoneum be accidentally opened, close it with Lembert's suture. Kocher's method is excellent, 4. and enables the surgeon to feel the opposite kidney before removing the one which is known to be diseased. The incision is begun as described on page 961, and is carried forward so as to expose the reflection of the peritoneum onto the colon in the posterior axillary line.[1] At this point the peritoneum is opened, and the hand is inserted into the abdominal cavity and feels the other kidney. If another kidney exists and it is found to be healthy, the diseased organ is removed.

Abdominal nephrectomy is more dangerous than the lumbar operation. The same instruments are required as are used in the preceding operation. The position is supine. The incision is that of Langenbeck—four inches long in the linea semilunaris, its center corresponding to the umbilicus. Open the abdomen, introduce a hand, feel the kidneys, and if both show serious disease do not perform nephrectomy. Keep the small intestine away by sponges, push the colon toward the umbilicus, incise the outer layer of the mesocolon, and bare the kidney. Strip off the peritoneum from the kidney and its vessels, and ligate the vessels by passing strong silk through the center of the pedicle with an aneurysm-needle. Ligate the ureter if healthy, and cut. If the ureter is septic, fasten it to an opening made in the loin by cutting onto forceps pushed to the outer edge of the quadratus lumborum. Stop bleeding, irrigate the belly-cavity, and dress as usual, employing drainage only when septic matter has gotten into the peritoneal cavity or when oozing is persistent.

Partial Nephrectomy.—This operation may be performed in some cases for wounds, cysts, and innocent tumors. After removing the damaged or diseased part bleeding points are ligated with catgut. The wound-surfaces are approximated as well as possible by catgut sutures. Drainage is intro-

[1] Kocher's *Text-book of Operative Surgery*.

duced. The value of partial nephrectomy in some cases seems certain, and we should apply it when possible instead of the complete operation.[1]

Renipuncture.—This is an operation devised by Reginald Harrison for the relief of albuminuria due to elevated tension. The kidney is exposed in the loin and the capsule is punctured or incised. Simple incision of the capsule will usually relieve nephralgia.

Nephrorrhaphy (or nephropexy) is fixation of a mobile kidney. The kidney is exposed in the loin as above detailed, and is forced out of the wound by Edebohls's method. The fibrous capsule is incised longitudinally and a cuff is turned down on each side. Sutures traverse the kidney-substance and two layers of capsule on each side. The upper suture catches the periosteum of the last rib, the lower sutures catch the lumbar fascia. Drainage is not required. The suture-material is kangaroo-tendon or chromicized catgut. Kocher's incision is shown in Fig. 107. Many surgeons simply pass sutures through the uncut capsule and kidney-substance, and fasten the kidney to the lumbar fascia. Other surgeons split the capsule, pull it into the wound, and pass sutures through only the capsule and wound-edges. After nephrorrhaphy keep the patient in bed for three weeks. A kidney which has been anchored will not unusually loosen at some future time.

Senn's Operation.—Many surgeons feel that it is not desirable to pass sutures through the kidney-substance. Urinary fistula has followed suturing. Again, the value of such sutures is very doubtful. The kidney is a very soft organ, and if it is suspended by sutures they are certain to cut out. Senn's operation fixes the kidney without using sutures.

The kidney is held in place by an assistant. A vertical lumbar incision is made, the perirenal fat is exposed and is torn through until the kidney is reached. The kidney is usually brought out of the wound. The posterior fatty capsule is cut away, and also the anterior capsule up to the hilum. The true capsule of the kidney is scarified, a long piece of iodoform gauze is placed under the upper end of the kidney, and another piece under the lower end. The kidney is replaced and will then lie in a sling, composed of two pieces of gauze, the ends of which protrude from the wound. Gauze is packed into the opening over and about

[1] See Oscar Bloch, in *British Med. Jour.*, Oct. 17, 1896; also, reports of Czerny, Bardenheuer, Tuffier, and Kümmell.

the kidney, and over this the two long pieces are tied. A large gauze pad is placed upon the abdomen over the anterior surface of the kidney, and the lumbar wound is dressed with gauze. The dressing and gauze pad are held in place by a binder. In about ten days the patient is anesthetized, the gauze is removed, and the granulating surface is lightly packed with gauze.[1] By this operation the kidney is surrounded with granulations, which are converted into scar-tissue, and the organ becomes encased in a box of fibrous tissue.

Ureterolithotomy.—If the stone is impacted in the upper two-thirds of the tube, make the incision advised for wounds of the ureter (p. 952). The operation is extraperitoneal. The tube is opened by a longitudinal incision. The stone is removed. The ureter is explored by means of a sound. It is not necessary to suture the ureter. The tissues above the ureter are sutured and a drainage-tube is carried to the duct (Fenger). If the stone cannot be reached by the extraperitoneal method, open the peritoneal cavity and incise the ureter. After removing the stone suture the wound in the ureter with silk inversion-sutures, fasten an omental graft over the suture-line (Fenger), and drain.

Uretero-ureterostomy (Van Hook's Operation).—In this operation ligate the lower end of the divided ureter with silk or catgut. About one-fourth of an inch below the ligature make an incision in the long axis of the tube. This incision is in length equal to twice the diameter of the tube. Each end of a piece of fine catgut is threaded to a fine needle. This thread is passed through the upper end of the ureter (Fig. 378). The needles are made to enter the lower end of the tube through the door made by the surgeon. They are pushed through the wall of the ureter one-half an inch below the window (Fig. 378). Traction upon the strings causes invagination and the ligature-ends are tied. If the operation is intraperitoneal, the ureter is wrapped about with peritoneum.

Intestinal Implantation of the Ureters.—This operation may be employed in exstrophy of the bladder and in vesical cancer, in which it is necessary to remove the bladder. After this operation there is danger of infection of the ureters and consequent ascending ureteritis, and pyelonephritis. After the operation the presence of urine in the bowel usually causes inflammation of the rectum, and incontinence of urine may take place.

[1] See John B. Deaver, on "Movable Kidney," *Annals of Surgery*, June, 1899.

Maydl asserts that a piece of the bas fond should be removed with the ureter, and implanted with it into the intestine, the flange hanging free in the lumen of the gut. If this is done, the relations of the ureter to the muscular coat of the bladder are not interfered with, stricture is less likely to

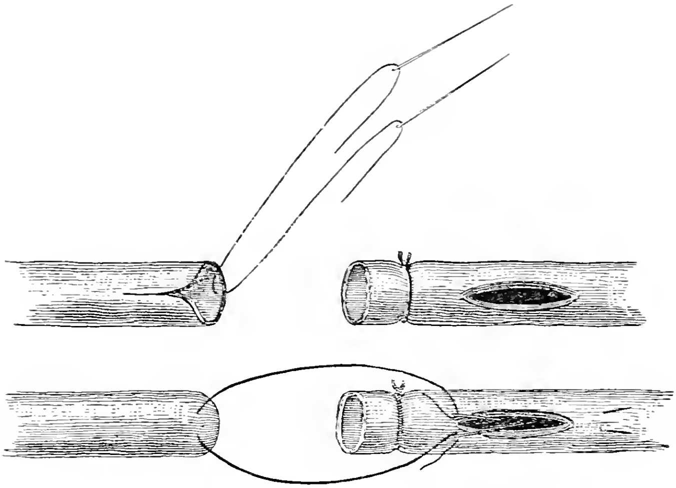


FIG. 378.—Van Hook's method of ureteral anastomosis.

occur, ascending infection is antagonized, and suppurative conditions arise at the margin of the flange, rather than as in other methods, directly in the cut ureter. Maydl has collected the records of fourteen cases operated upon by this method, with two deaths.[1]

DISEASES AND INJURIES OF THE BLADDER.

Retention of Urine.—By this term is meant an inability to empty the bladder. The retention may be *complete*, not a drop emerging, or it may have been complete, a dribbling setting in after a time, due to paralysis of the bladder, which cannot contain more fluid, expulsion of the overflow from the ureters being produced by atmospheric pressure. This condition is known as *the engorgement, the overflow*, or *the incontinence of retention.* There may be a *partial* retention from enlarged prostate, a portion only of the urine being voided. Retention may be caused by—(1) *obstruction*, resulting from urethral stricture, hypertrophied prostate, inflamed

[1] Editorial in *Jour. Amer. Med. Assoc.*, May 6, 1899.

prostate, occluded meatus, impacted calculus, urethral tumor, complete phimosis, fecal impaction, and pressure from a large tumor, or by (2) *defective expulsion*, resulting from paralysis, disease or injury, atony, reflex inhibition, shock, muscular weakness of fevers, and the action of such drugs as belladonna, opium, or cantharides.

Symptoms.—In acute retention there is an agony of desire to urinate, the patient making acutely painful straining-efforts, during which feces are often passed. There are severe pain and aching in the abdomen, thighs, perineum, and penis. All the symptoms rapidly increase, a typhoid state is inaugurated, and death closes the scene unless relief be given. If retention is from time to time alleviated by the passage of a little water, the symptoms are slower in evolution and are less intense, and the case is said to be chronic. Some cases of gradual onset, due to atony, are very insidious, the patient feeling no particular pain and complaining only of the dribbling, which is really the overflow of retention, and is not a sign that the bladder is successfully emptying itself. In any case of retention the bladder rises above the pubes, and there is found a pyriform, elastic, fluctuating mass (dull on percussion) in the hypogastrium, which mass gradually enlarges until the bladder is evacuated or incontinence sets in. The flanks give a clear percussion-note, and the tumor is more prominent when the patient is erect than when recumbent. Long continuation of obstructive disease, producing partial retention with or without attacks of complete retention, disorganizes the kidneys. Acute and complete retention may induce rupture of the urethra or urinary suppression.

Treatment.—Place the patient upon his back, keep him warm, and if instrumentation does not rapidly succeed, give an anesthetic. Be sure that every instrument is aseptic. In *organic stricture* try to pass a soft catheter; if this fails, endeavor to insert a hard catheter. Try a large size first, and gradually go to smaller sizes if the larger instrument will not pass the obstruction. When the instrument enters the bladder draw off but half of the urine, withdraw the instrument, wait a few hours, insert it again and then empty the bladder and wash out the viscus with hot boric-acid solution. To draw off all of the urine at once is dangerous, because the sudden relief of pressure from distended veins leads to bleeding from the mucous membrane and hemorrhage into the bladder-walls. Fig. 381 shows several varieties of rubber catheters, and Fig. 383 shows a silk

catheter. Fig. 382 shows the proper curve and the improper curve for a metal instrument. After the bladder has been emptied the patient is wrapped in blankets, a bag of hot sand is placed against the perineum, and a hot-water bag over the hypogastric region; when he recovers from the effect of the anesthetic he is given suppositories of opium and belladonna, and tablets of salol and boric acid are

FIG. 379.—Gouley's tunnelled catheter threaded on a filiform bougie.

administered for several days. If it is found impossible to insert a rubber instrument or a metal catheter, make an attempt to carry a filiform bougie into the bladder. Fig. 380 shows filiform bougies. If the stricture is known to be organic from previous history, at once insert a filiform bougie. On this bougie Gouley's tunnelled catheter can be threaded (Fig. 379) and carried into the bladder, the viscus being half emptied. Instead of carrying in the catheter, we can leave the filiform in place, and fasten it. The filiform bougie will act as a capillary drain, and in a few hours will empty the bladder. Then insert another bougie beside the first, and so on for several days, using also opium, ordering rest in bed, and making no attempt to dilate the stricture forcibly until retention has ceased and inflammation has subsided.

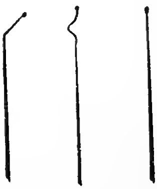


FIG. 380.—Points of Gouley's whalebone guides.

If no bougie can be passed, aspirate or perform cystotomy (suprapubic or perineal). In *spasmodic stricture* hold a good-sized metal catheter firmly against the face of the spasmed area; relaxation will occur and the instrument will eventually pass. An individual who has an organic stricture which has given but little trouble may develop attacks of retention because of inflammatory edema of the mucous membrane and spasm of the urethral muscles. These attacks are temporary, and an instrument can usually be inserted when employed as above directed. In *inflammation* give a hot hip-bath and sup-

positories of opium and belladonna, and then use a hot sand-bag to the perineum and a hot-water bag over the hypogastrium. If these fail or if the symptoms are urgent, pass a soft catheter. In the *occluded meatus of the new-born* incise with a tenotome. In a *congenital cyst of the sinus pocularis* pass a steel bougie, which will rupture the cyst. In *complete phimosis* split up the prepuce. In *impacted stone* try to pull it out with urethral forceps; if this fails, cut the urethra, or, in rare cases, push it back into the bladder. In *fecal impaction* scrape out the rectum with a spoon. In *enlarged prostate* insert a coudé catheter (Fig. 381, *b*) strengthened by the insertion of a filiform bougie nearly to the beak, or pass a silver instrument with a large curve. In *retention from expulsive defect* use a soft catheter. Cases of retention require warmth, confinement to bed, the

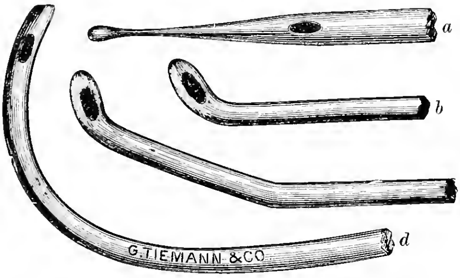


FIG. 381.—*a*, French olivary gum catheter; *b*, Mercier's elbowed catheter (coudé); *c*, Mercier's double-elbowed catheter; *d*, curved gum catheter.

administration of laxatives, free action of the skin, and the use of such drugs as salol, boric acid, urotropin, and quinin to asepticize the urine. In some few cases no instrument can be inserted in the bladder. In most of such cases aspirate—which may be done several times if necessary—and in a day or two, when swelling and congestion abate, an instrument can be passed. A small asepticized trocar or aspirator-needle is pushed into the bladder, the trocar or needle being inserted in the median line, just above the pubes, and taking a course downward and backward. The parts are first prepared antiseptically, and the puncture is dressed with iodoform and collodion. Only half of the urine is withdrawn at a first aspiration. Rectal puncture is now obsolete. The perineal incision is not advocated for retention unless rupture of the urethra has taken place. When a catheter is used for retention the patient must be recumbent to minimize shock.

Congenital Defects of the Bladder.—Exstrophy of the Bladder (*Ectopia Vesicæ*).—Exstrophy of the bladder is a condition of defective development commoner in males than in females. The anterior abdominal wall having failed to close, the anterior wall of the bladder being absent, and the arch of the pubes not having developed, epispadias exists, and in many cases the testicles do not descend into the scrotum. In this condition the posterior wall of the bladder projects into or beyond the gap in the abdominal walls; the urine constantly flows and renders the condition of the patient dreadful.

The only treatment which offers hope is operation, and operation often fails. If possible, operate when the patient is about five years of age. Various operations have been suggested for this condition, viz.: covering with skin flaps; implanting the ureters into the rectum (Maydl, Albert, Roux, Simon, and others); division of the posterior ligaments of the sacro-iliac joints, bringing the arch of the pubes forcibly together, the patient wearing a support until the parts become firm, when the defect is closed in by flaps (Trendelenburg); or loosening the ureters from the bladder, drawing them down, and attaching them to the end of the penis (Sonnenberg).

Diseases and Injuries of the Bladder.—This viscus is so deeply situated, and the abdominal walls are so elastic, that it is rarely injured when empty. If the bladder be full and the abdomen be tense—which is common in alcoholic intoxication—force applied upon the abdomen may injure the bladder.

Contusion of the Bladder.—In this condition there are noted vesical hematuria, tenesmus, severe cystitis, and an impediment to the flow of water because of clots. Hemorrhage may be very severe and sepsis may arise, even causing death. When contusion exists retention is relieved by means of a clean soft catheter; if this fails because of occlusion of the eye of the catheter with blood-clot, there must, from time to time, be passed through the catheter from a fountain-syringe a solution of sodium bicarbonate in cooled boiled water. Gross's blood-catheter can be used, or the evacuator of Bigelow may be employed. The patient is put to bed, a hot-water bag is applied to the hypogastrium, morphin is administered in moderate doses, the bladder is washed out several times a day with boric-acid solution to disintegrate and remove blood-clots, and the urine is diluted and rendered aseptic by the stomach administration of salol,

boric acid, and the free use of bland fluids. Hemorrhage usually ceases on relieving distention; if it does not, some more radical measure must be employed (see Hematuria).

Besides being contused, the bladder may be injured by bullets; by stabs or punctures through the abdomen, the vagina, or the uterus; or by penetration by a fragment of a fractured pelvic bone. The symptoms of such conditions are those

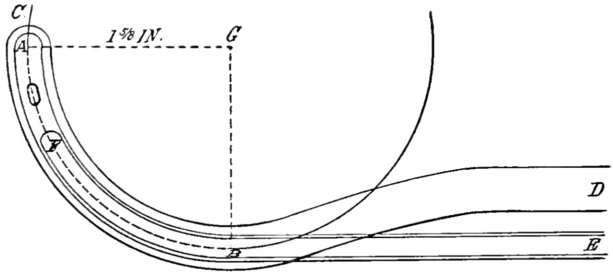


FIG. 382.—*A B E* shows the proper curve (reduced in size) for unyielding male urethral instruments; *C B D* shows an improper curve.

of rupture of the bladder (*q. v.*). In any intraperitoneal wound at once open the abdomen, suture the wound in the bladder-wall, irrigate the peritoneal cavity, and drain the bladder by means of a retained catheter, a perineal section, or a suprapubic cystotomy. In an extraperitoneal wound drain the wound by a tube, and drain the bladder by a retained catheter, a perineal section, or a suprapubic opening.

Rupture of the bladder occurs in three forms: (1) intraperitoneal—a rupture involving the peritoneal coat; (2) extraperitoneal—a rupture of a portion of the bladder not covered by peritoneum; and (3) subperitoneal—a rupture of the mucous and muscular coats, the urine diffusing under

FIG. 383.—English silk-web catheter.

the peritoneal investment. The *causes* are of two kinds, predisposing and exciting. *Predisposing* causes are—distention of bladder; drunkenness; ulceration; degeneration or atony of the bladder-coats. *Exciting* causes are—obstruction to outflow of urine (by stricture or enlarged prostate); external violence; falls upon the feet and the buttocks, as well as upon the abdomen; lifting; straining at stool in

micturition, or during parturition; and the forcing of injections into the bladder. This accident is commoner in men than in women (10 to 1), and is rare in children.

Symptoms, Diagnosis, and Treatment.—The symptoms are not always definite, and every characteristic one may be for a time absent, the patient seeming in some rare instances to possess the power of retaining his urine and of voiding it. As a rule, however, there are found some or all of the following symptoms, following an accident or occurring during the progress of a causative disease: collapse; excessive desire to urinate; inability to do so; a catheter, when used, brings away pure blood or a very little bloody urine; the catheter occasionally slips through the tear into the cavity, and more bloody water comes away; severe hypogastric pain comes on after a temporary sense of relief from retention; shock is so severe that death may ensue; if reaction follows, there is delirium, often septicemia and peritonitis; extensive infiltrations of urine may occur. In *intraperitoneal rupture* general peritonitis is certain to arise, but its appearance may be postponed for several days if the urine is healthy. In these cases the extravasation is noted as a simple swelling, probably on one side only. In *extraperitoneal rupture* the urine may infiltrate the perineum, the scrotum, the thighs, and under the integuments of the abdomen and the back, and may soon induce sloughing. In *subperitoneal rupture* peritonitis is apt to arise. Injecting fluid fails to lift the bladder into the hypogastric region so as to be recognizable on percussion. If there is injected a measured amount of fluid, less will run out than went in.

In doubtful cases pump air into the bladder. A bicycle pump can be used (Brown), or a Davidson syringe (Keen). Keen's directions are to insert a catheter, empty the bladder of urine, and connect to the catheter a disinfected Davidson's syringe, a mass of absorbent cotton being fastened over the distal end of the syringe. Air after it has filtered through the cotton is pumped into the bladder: an unruptured bladder will rise above the pubes as a pyriform tumor, tympanitic on percussion; a ruptured bladder will not so rise, but the air will pass into the general peritoneal cavity. In intraperitoneal rupture the general peritoneal cavity will be distended with the air. In extraperitoneal rupture injection will produce emphysema of the extravesical connective tissues. On removing the syringe the air rushes out again if the bladder is unruptured, but little if any comes away if it is ruptured. Senn recommends injecting hydrogen gas instead

of air. The *treatment* of rupture of the bladder is the same as that for wounds of the bladder.

Atony of the bladder is a condition in which the expulsive power of the bladder is diminished or lost because of impairment of muscular tone. The bladder is very thin, and the muscles are flaccid and often the seat of fatty degeneration. Sometimes the viscus is very large and sometimes it is very small. A slight degree of atony is physiological after middle age. The **causes** are senility, distention from true paralysis, chronic overdistention from obstruction, and acute overdistention.

Symptoms.—In atony of the bladder the patient passes water frequently (a symptom probably existing for some years), and especially at night; he may even do so while asleep. The stream, when voluntarily passed, has no projection, but drops at once from the end of the penis. Residual urine exists for years and may at any time set up cystitis, and retention with incontinence is apt to occur. This condition is *not* vesical paralysis resulting from a lesion of the nervous system.

Treatment.—In treating atony of the bladder measure the residual urine: if it amounts to four ounces, use a soft catheter night and morning; if it amounts to six ounces, use the catheter every eight hours; if it amounts to eight ounces, use the catheter every six hours (J. W. White). The patient should be taught how to use the catheter and how to keep it sterile. (For methods of disinfecting catheters see article on Hypertrophy of the Prostate Gland.) The bladder is from time to time washed out with gr. iij to the ounce of boric-acid solution at a temperature of 100° F. Strychnin, electricity, ergot, and urotropin may be ordered.

Vesical Calculus, or Stone in the Bladder.—The salts normally in solution in the urine may deposit as calculi and may be imprisoned in any portion of the urinary tract. The commonest calculi are those composed of uric acid, urates, calcium oxalate, and fusible phosphates. The formation of uric-acid and urate calculi is explained under Renal Calculus (p. 952). Vesical calculi are usually renal calculi that have passed the ureter and become enlarged by new accretions. Phosphatic calculi may be formed in the bladder when chronic cystitis causes and maintains an alkaline urine. Uric-acid calculi are smooth, round or oval, and hard, but easily broken. On section they present the color of brick-dust and are marked by concentric rings. Their nuclei are dark by comparison. They are soluble in dilute

potassium hydrate, and with effervescence in nitric acid. They are combustible, and leave scarcely any ash. Urate of sodium and urate of ammonium often occur together in stones, and these calculi are not in rings, are not so hard as the uric-acid stones, and are fawn-colored on section. Oxalate-of-lime stones are round with many projecting nodes like the mulberry, hence the term "mulberry calculus." They are very hard, and section shows the color to be brown or green and that they possess wavy, concentric rings. This form of calculus is soluble in hydrochloric acid. Fusible calculus, which is composed of magnesic ammonic phosphate with phosphate of lime, constitutes the commonest form of phosphatic stone and of large stone. It is light, soft, smooth, and white, and shows no laminæ on section. Some rare forms of stone are composed of xanthic oxid, cystic oxid, calcium phosphate or carbonate, and magnesic ammonic phosphate (triple phosphate).

A stone may be formed having layers of different substances; for instance, there is often found a uric-acid nucleus surrounded by phosphates, the latter surrounded by some uric acid or urates, and these again by phosphates. In some cases oxalate of lime alternates with uric acid, urates, or phosphates (Bowlby). Bowlby states that the alternating uric-acid and phosphatic layers are due to the altering reactions of the urine; that when the urine is acid uric acid is deposited on the stone, but when cystitis makes the urine alkaline the stone receives a phosphatic coat.

Anything that favors the formation of an excessive urinary deposit may cause vesical calculus, and among such causes are defective digestion, failure in processes of oxidation, excess of solids and nitrogenous elements in the diet, deficient exercise, etc. If to the urinary condition established by the above factors catarrh of the genito-urinary tract is added, pus or mucopus in the concentrated urine may induce stone. Children are predisposed to uric-acid stones, and old people to phosphatic stones. In an old man with enlarged prostate and chronic cystitis a stone forms rapidly about any accidental nucleus. The nucleus may be phosphate-crystals glued together by mucus, a blood-clot, uric-acid gravel, or a foreign body. Stone is rare in females because of the shortness, the large diameter, and the ready dilatability of the urethra. Stone is very rare in the negro. Gout, rheumatism, lithemia, enlarged prostate, vesical atony, urethral stricture, and catarrhal inflammation of the kidney, the ureter, and the bladder are predisposing causes.

9

Symptoms.—In not a few cases the vesical symptoms are antedated by an attack of nephritic colic. The severity of the symptoms depends more on the roughness of the stone than on its size. A small, rough calculus will produce intolerable anguish, whereas several large, smooth stones will cause but moderate pain. A patient with stone in the bladder complains of frequency of micturition, particularly in the daytime, the desire being sudden, uncontrollable, and invoked or aggravated by exercise. This symptom is more positive in youth than in old age. Pain of a sharp, burning character is experienced at the end of micturition, due to the contraction of the empty bladder upon the stone. The usual seat of this pain is the under surface of the head of the penis, a little behind the meatus, and the pain may continue for some time. By pulling on the penis to relieve this pain the prepuce often becomes pendulous. This pain varies in severity, being worse during cystitis and after exercise; it may be absent in encysted stone, it may even almost disappear, and it is always worse in the young than in the old. Stone in chronic cases of atony and in cases of vesical paralysis causes neither marked pain nor frequency of micturition.[1] Attacks of cystitis in a man with calculus are spoken of as attacks of stone. When a stone is small it may during micturition roll into the urethral orifice, and so cause a sudden interruption of the flow of water, the stream again starting when the patient changes his position. This symptom is rare in the old, the stone in them dropping into the sac back of the prostate and *below* the urethral orifice. Hematuria may or may not be noted; it is most usual after exercise, and occurs at the end of the urinary act. Pus or mucopus will be observed if cystitis occurs. Priapism occurs in some cases. Pain of a reflex nature may be felt in the rectum, in the perineum, or in some distant part.

The above symptoms, even if all are present, do not prove that an individual has a stone in the bladder. To prove the presence of a stone, it must be touched with a sound and the contact must be felt and heard. To sound a patient, have the bladder well filled with water, and place him recumbent with the knees drawn up. Never sound a person while he is standing, because of the danger of syncope. In an ordinary case use a sound with a very slight curve; in a man with hypertrophied prostate use a sound with a short and decided curve. The caliber of a stone-sound is No. 13 of the French scale. The instrument is carefully boiled and anointed

[1] *American Text-book of Surgery.*

with glycerin. Examine the entire bladder systematically, and never operate unless a stone be both heard and felt. The stone may be hard to find, or it may elude the instrument entirely when it is encysted, when it rests in a diverticulum, when it is fixed to the roof or anterior wall of the viscus, or when it is crusted with lymph or blood-clot. In doubtful cases always insist on a second examination, giving ether if the first was very painful. Occasionally a small stone will be found by using a Bigelow evacuator, the current causing the calculus to knock against the tube. In many cases stone in the bladder may be detected by means of the x-rays. A stone, when it is detected, should always be measured by an arrangement like a lithotrite. The composition of the stone is assumed from an examination of fragments which pass by the urethra or which adhere to the measure. Remember that the outer layer of a calculus may be soft phosphate and the inner portion may be the harder uric acid, urate, or oxalate. Examine for stone in females with a straight sound, and in cases of uncertainty dilate the urethra and explore the bladder with the little finger.

Treatment.—In people predisposed to stone (for instance, by lithemia) the physician should forsee the danger and essay to antagonize it. Insist on the urine being kept dilute by the freest use of water and of milk, and reduce to a minimum the amount of alcohol, meat, sugar, and fat which is taken. Let the patient live chiefly on green vegetables, salads, bread, fruit, eggs, fish, poultry, weak tea or coffee, water, milk, and, if desired, a little red wine. Continued purging does harm by concentrating the urine, though a laxative may be employed when indicated. Moderate open-air exercise is of immense importance, sunshine and fresh air being Nature's correctives for a condition of imperfect oxidation power. If the urine be very acid, use piperazin, gr. xv to gr. xx daily, liquor potassii citratis, phosphate of sodium, or borocitrate of magnesium. If the urine be phosphatic, order mineral acids and strychnin, or what seems to be very efficient, urotropin. Urotropin is given in gr. v capsules four times daily. If the urine be filled with oxalate, use the mineral acids with an occasional course of phosphate of sodium. Travel and rest at the seaside or at some spa are often of service in all forms. Always endeavor to prevent cystitis, and treat it promptly when it does occur. When a stone is once formed it is an idle dream to think of dissolving it. An operation must be done. The operation selected depends upon the age, the state of the bladder and the prostate, the dilatability of the urethra, the kidney con-

dition, the size and composition of the stone, and the number of calculi present (see Operations on the Bladder).

Cystitis.—Inflammation of the bladder is, as a rule, a complication of some other disease of the genito-urinary tract, but it may arise from cold and wet. Traumatism from a catheter, the presence of a stone, the spread of a urethral inflammation, pus infection, the existence of tuberculosis or cancer, and the use of such a drug as cantharides, may produce it. It appears not unusually during an exanthematous fever or in conditions of vesical paralysis; it often follows retention, frequently accompanies enlarged prostate and urethral stricture, and sometimes arises from concentration of urine or accompanies bladder growths. Acute cystitis causes discoloration and swelling of the bladder-walls, and there is present a catarrhal discharge which is mixed with urinary elements, serum, mucus, often pus and epithelial débris. Ulceration, sloughing, or false-membrane formation may occur. Chronic cystitis is an inflammatory condition always due to bacteria. We frequently speak of a chronic cystitis as due to stone in the bladder, hypertrophy of the prostate gland, or tumor of the bladder. These conditions do not cause chronic cystitis, but act by rendering the bladder vulnerable to micro-organisms. Among the causative organisms we may mention the bacillus coli communis, the gonococcus, the bacillus tuberculosis, the bacillus typhosis, and the various pyogenic bacteria (Leonard Freeman). These bacteria may gain entrance on instruments; or by way of the ureter, urethra, the lymph-vessels, and possibly in rare instances by the blood.

In chronic cystitis there is an enormous production of thick, sticky mucus and the urine becomes alkaline. The excessive secretion of mucus and the great number of bacteria convert the urea into carbonate of ammonium, and this product, being irritant to the bladder-walls, makes the inflammation worse. In chronic cystitis the bladder is contracted and has very thick walls, and the mucous membrane is thick, edematous, congested, and filled with large veins. The bladder may be ulcerated or encrusted with urinary salt. The urine contains bacteria, triple phosphate, pus, blood, and mucus, the blood emering with the last drops of water. Pyelitis may arise as a result of chronic cystitis.

Symptoms of Acute Cystitis.—Great frequency of micturition, with the passage at each act of a very small quantity of urine; the desire to urinate is almost constant, and there is intensely painful straining (tenesmus). The pain is

acute and scalding, and may be felt above the pubes or in the perineum; it often runs into the loins and the thighs and radiates over the sacrum. Pain above the pubes indicates involvement of the fundus, and pain in the perineum and in the head of the penis points to inflammation of the bladder-neck. The urine, at first clear, loses its transparency, becomes full of thick mucus, and often contains a little blood or pus. The patient not unusually has some fever. A rectal examination causes violent pain. If ischuria takes place, there will be a chill and high fever, and anuria may occur or vesical rupture may ensue.

Treatment.—In treating acute cystitis endeavor to remove the cause. By allaying an irritation or removing an obstruction the bladder will often become able to empty itself of retained urine, which urine causes congestion of the bladder and thus renders infection probable or may be itself filled with bacteria. If cystitis arises from the administration of cantharides, put the patient in bed and give him liquor potassii citratis. If it comes from the use of a clean sound, order rest in bed, suppositories of opium and belladonna, diluent drinks, and the use of ammonii benzoas or of lupulin. If the inflammation is septic (as from the use of a dirty sound), or is very acute, put the patient in bed, keep him warm, and use a hot sand-bag to the perineum and hot fomentations or poultices to the hypogastrium. Hot hip-baths may be used. The hips had best be elevated and the bowels be emptied by salines and glycerin enemata. An exclusive milk-diet is desirable. The patient should drink copiously of sweetened water containing a few drops of aromatic sulphuric acid or of milk of almonds. Sterilize the urine by the administration of urotropin, giving a capsule containing gr. $7\frac{1}{2}$ of the drug three times a day. Other remedies which may be of service in sterilizing the urine are quinin, boric acid, salol, brocitrate of magnesium, and salicylate of sodium. Wash the bladder out daily with warm normal salt solution or warm boric-acid solution. This can be done through a soft catheter or better by hydrostatic pressure. A valuable remedy consists of 15 grains of salicylate of sodium and 15 grains of benzoic acid, given three times a day in a little chloroform water. If the pain and straining still continue, order—

℞. Ext. sem. hyoscyamin.,	gr. viij;
Ext. cannabis indicæ,	gr. viij;
Sacchar. alba,	gr. xlviij.—M.
Div. in pulv. No. xx.	
Sig. One powder every three hours.	(Von Zeissl.)

Or,

℞. Camphora,	gr. viij;
Ext. cannabis indicæ,	gr. viij;
Sacchar. alba,	gr. xlviij.—M.
Div. in pulv. No. xx.	
Sig. One powder every three hours.	(Von Zeissl.)

Suppositories of extract of belladonna are of great value. Suppositories each containing gr. j of ichthyol are of service; and one should be used every four hours. If these remedies fail, the surgeon will be driven to order opium, which, unfortunately, constipates; when it is used, secure evacuations by the use of glycerin suppositories, by the administration of saline cathartics, or by the employment of enemata. Give a suppository containing gr. j of powdered opium and gr. $\frac{1}{6}$ of the extract of belladonna every three or four hours. Hypodermatic injections of morphin may be required. If retention occurs, use a soft catheter. If much blood is passed, give internally the tinctura ferri chloridi and blister the perineum. A very acute cystitis is rarely arrested within a week or ten days.

Symptoms of Chronic Cystitis.—This condition may be a legacy from acute cystitis or it may appear without any acute precursory phenomena. There will be found frequency of micturition, but not so great as in the acute form. There will be slight tenesmus, and moderate pain from time to time, running toward the head of the penis. Constitutional symptoms arise only when kidney-damage has become pronounced or sepsis has occurred from absorption. The urine is ammoniacal, fetid, and turbid; it is filled with viscid, tenacious mucus or with mucopus; it contains a great excess of phosphates, and occasionally clots of blood. The condition of chronic cystitis with the production of immense quantities of thick mucus is often called "chronic catarrh of the bladder." Chronic cystitis may eventuate in the formation of stone or in the production of serious diseases of the bladder, the ureters, and the kidneys. It often occasions retention. Chronic cystitis may be due to tuberculosis. Some cases come on suddenly, many tubercle bacilli being found in the urine. In many cases no tubercle bacilli are found. The tubercular products caseate or fibrous organization takes place. A cystitis for which no cause can be found, and which is accompanied by pyuria and pain, is possibly tubercular. The cystoscope in these cases should only be used by an expert.

Treatment.—In treating chronic cystitis remove the cause

if possible (get rid of a stone, evacuate residual urine frequently, dilate a stricture, and remove a tumor). For chronic cystitis certain remedies are taken by the mouth. Water is drunk in large amounts, also iron spring-water (Marienbad, etc.). Salol and boric acid, gr. v of each four times a day, are very valuable. Salol in fluid extract of triticum repens does good; so does chlorate of potassium, gr. x daily. Either borocitrate of magnesium, quinin, or salicylate of sodium with benzoic acid may often be used with benefit. Alum, tannic acid, uva ursi, copaiba, cubebs, buchu, and turpentine have all been recommended, and possibly may be of some benefit. Urotropin is useful in cases of chronic cystitis. This drug prevents the development of bacteria in the urine (Nicolaier), and antagonizes the tendency to sepsis and urinary poisoning. It is given in 5-grain capsules, from four to six being given daily. Whatever remedy is used, see that the bowels move once a day, and that the skin is active. Champagne and beer must be avoided. If residual urine gathers, a soft catheter must be regularly used. If it is possible to introduce a catheter of considerable size, catheterization may be all that is needed in the case. In some cases of chronic cystitis the retention of a catheter from three to five weeks is of the greatest service. If the case is very severe, the bladder must be washed out daily with peroxid of hydrogen (25 to 40 per cent. solution), nitrate of silver (1 : 8000), boric acid (5 to 10 per cent.), carbolic acid (1 : 500), corrosive sublimate (from 1 : 5000 to 1 : 20,000), or permanganate of potassium (1 : 4000). If nitrate of silver or permanganate of potassium is used, first rinse out the bladder with distilled water. If any other agent is used, first wash out the bladder with boiled water. The daily injection of a 2 per cent. solution of ichthyol may prove useful. Some surgeons occasionally employ, at intervals of a number of days, strong silver solutions (30 or 40 grains to the ounce). If a strong solution is used, after the drug flows away wash out the bladder with a solution of common salt. The bladder is usually washed out by attaching to the free end of a soft catheter, the other end of which is in the bladder, a tube which is connected with a graduated bottle, the force being obtained by elevating the reservoir (fountain irrigation). The bladder can be irrigated without using a catheter, the resistance of the compressor muscle of the urethra being overcome by the pressure of a column of water. The reservoir is raised to the height of six feet. The patient sits in a chair. The tube of the reservoir has

upon it a clamp to control the flow, and in its end a large bulbous tip which will fill the meatus (Valentine's instrument). The tip is inserted into the urethra, the clamp on the tube is loosened, and the patient is directed to take a deep inspiration. In a short time the bladder fills with water, the tube is removed, and the patient empties the viscus naturally. In some cases it is necessary to wait quite a while for the column of water to tire out the muscle. If the fluid will not enter, direct the patient to urinate, and then make another attempt. After a little practice a patient learns how to admit the fluid.

In tubercular cystitis Collin advises the instillation of 30 minims of the following mixture into the bladder and posterior urethra: 5 gm. of guaiacol, 1 gm. of iodoform, 100 gm. of sterile olive oil. About 30 minims of this are injected once a day. In ordinary non-tubercular cystitis he uses a 1 per cent. solution of guaiacol carbonate in oil. If the ordinary methods of treatment fail, if the bladder resents catheterization and irrigation, if in spite of irrigation the urine does not become clear, and if there are evidences of infection of the patient and breaking down of his general health, drain by perineal or suprapubic cystotomy (see Perineal Section, page 1018) and through the incision wash the bladder frequently and thoroughly. If the persistent cystitis is due to stricture which dilatation fails to cure, perform external perineal urethrotomy and employ perineal drainage.

Tumors of the Bladder.—Tumors of the bladder may be either innocent or malignant, the latter being the commonest. Innocent tumors which may arise from the bladder are papillomata or villous tumors, mucous polypi, and fibrous polypi; malignant tumors are sarcoma (rare) and carcinoma (encephaloid, rare, epithelioma, common).

Symptoms.—The innocent tumors rarely cause cystitis or irritation, though by obstructing the ureters or the urethra they may induce disease of the kidneys. Often hemorrhage is the only phenomenon produced by a papilloma or a mucous polyp. Malignant tumors cause cystitis, and the urine contains mucus, blood, and pus. Innocent tumors are hard to feel with the sound, but malignant tumors are easily felt. In some cases a tumor can be detected by a bimanual examination (a finger in the rectum and the fingers of the other hand on the abdomen). Make a careful study to determine whether or not growth has infiltrated the prostate, the seminal vesicles, the rectum, or the perivesical tissues. The bleeding in bladder-growths is apt to be profuse,

and it occurs intermittently. Bleeding follows the use of a sound. The urine should be examined microscopically to see if it contains villi, portions of fibroma, colonies of cancer-cells, or fragments of epithelioma (White). A cystoscope should be employed in order to reach a diagnosis. In doubtful cases exploratory suprapubic cystotomy is advisable.

The treatment is by suprapubic cystotomy and removal of the growth. The perineal operation only enables the surgeon to reach and remove growths of small size, pedunculated growths, and growths near the neck of the bladder. (See Operations on the Bladder.) Chismore has suggested the removal of polypoid growths by means of Bigelow's evacuator. When the growth catches in the eye of the instrument it is torn off by slight traction and gentle rocking, and the suction which is being made carries it into the reservoir.

Operations on the Bladder.—Lateral Lithotomy.—*Lithotomy* is the removal of a stone from the bladder. *Lateral lithotomy* is an operation which is every year becoming less popular, but which is still employed by many famous surgeons, especially for stone in children. This operation should not be performed if the stone is over two inches in its short diameter; it is rarely justifiable if the stone weighs three ounces or more (Cage); and it must not be performed for encysted stone, or on a person with a deep perineum, a narrow pelvic outlet, or an enlarged prostate. For one week before the operation keep the patient in bed, wash out the bladder daily with hot boric-acid solution, and administer salol and boric acid by the mouth, gr. v of each four times a day. The night before the operation give a saline, order a hot bath, and have the perineum, the scrotum, the buttocks, and the inner sides of the thighs cleansed and dressed antiseptically. In the morning an enema is to be given. At the time of operation the bladder should contain several ounces of boric-acid solution. The instruments required are a lithotomy-knife, a straight probe-pointed bistoury, a grooved staff, a stone-sound, stone-forceps and scoops, a tenaculum, an aneurysm-needle, a fountain-syringe, curved needles and a needle-holder, hemostatic forces, a tube with chemise (Fig. 95), a Paquelin cautery, a Clover crutch, and a lithotrite.

Place the patient upon his back, anesthetize him, and find the stone by sounding. If the stone is not discovered by the sound, *do not operate*. Place the buttocks so that

they project beyond the edge of the table, introduce the staff into the bladder, flex the legs and thighs, and fasten the patient in the lithotomy position with a crutch. During the first incision the handle of the staff is held toward the belly; after the first cut the staff is set perpendicularly and is hooked up under the pubes. An incision is made, starting just to the left of the raphé of the perineum and one and a quarter inches in front of the edge of the anus, and passing downward and outward to between the anus and the ischial tuberosity, but one-third nearer the former than the latter. In the adult this incision is three inches long. The first incision is superficial and does not reach the staff, but it is this incision which may cut the rectum. After making the first cut, the nail of the left index-finger feels for the groove of the staff, the staff is hooked up, the knife is entered into the groove and is pushed into the bladder, and as it is withdrawn the wound is enlarged. As the knife enters the bladder there is a gush of fluid. The finger follows the knife and stretches the wound, the staff is withdrawn, and the stone is felt for and extracted with forceps. Liston showed years ago the value of keeping the finger in the wound. This maneuver retains some water in the bladder, and as a consequence causes the stone to rest at the lowest part of the viscus, and when the forceps are introduced they at once come upon the stone. In withdrawing the stone make traction in the axis of the pelvis, and do not rotate the calculus until it is entirely out of the prostatic urethra. Wash or scrape away débris or incrustation, see that no other stone is present, syringe out the bladder with hot salt solution, insert a tube, apply antiseptic dressings around the tube, and put on a T-bandage. The end of the tube which is external to the dressings is fastened to the tails of the T-bandage. A rubber cloth is put on the bed, under the body and legs, and the patient's buttocks rest upon a mass of old linen, the scrotum being raised on a pad. The knees are bent over pillows. Change the linen as soon as it becomes wet. Remove the tube in forty-eight hours. The urine begins to come by the urethra from the eighth to the twelfth day. In children the incision is not so long, and is dilated with forceps instead of with the finger; no tube is required. In lateral lithotomy the prostatic and membranous portions of the urethra are opened, the prostate gland is partly divided with the knife, and the wound is dilated with the finger. One objection to the operation is that it is possible to

cut the rectum, and another is that inflammation may occlude the ejaculatory ducts.

Suprapubic Lithotomy.—This operation is the removal of a stone through an opening over the pubes. It is in many instances the preferable operation. The mortality of this operation is higher in children than that of lateral lithotomy; in adults and in individuals beyond middle life the mortality is decidedly less than is that following the lateral operation. It is used for the removal of multiple calculi, for very hard stones, for stones above one and a half inches in diameter, for calculi in men with enlargement of the prostate, for foreign bodies incrusted with sediment, when the perineum is deep, when the pelvic outlet is narrow, for encysted stones, for calculi associated with a vesical tumor when the urethra will not permit the use of a lithotrite. The patient is prepared as for lateral lithotomy, except that the pubes are shaved, and the lower part of the abdomen and the upper part of the thighs are disinfected. During the operation the penis is wrapped with a piece of antiseptic gauze. The instruments required are a scalpel, a probe-pointed bistoury, scissors, a tenaculum, blunt hooks, hemostatic forceps, retractors, dissecting-forceps, a dry dissector, an electric forehead-light, a rectal bag, a brass syringe or a bicycle-pump, a sound, rubber tubing, rubber catheters, stone-forceps and scoops, a bladder-tube, curved needles and a needle-holder, and a graduated glass jar for injecting the bladder.

In performing the *operation* place the patient in the Trendelenburg position. It is necessary to distend the bladder and raise it in order to have a prevesical space uncovered by peritoneum. Have an assistant oil the rectal bag and push it above the sphincters. Draw off the urine with a soft catheter, wash out the bladder with warm boric-acid solution (1 : 32), and inject the bladder with the same solution. In a child under the age of five inject three to four ounces; in an adult inject ten to twelve ounces. Withdraw the catheter and tie a tube around the penis to prevent the escape of fluid. After injecting the bladder with fluid, if the viscus is not well lifted, inject the rectal bag with water and clamp its tube with forceps. In a child inject from two to four ounces of warm water into the rectal bag; in an adult inject ten ounces. Bristow suggested the injection of air into the bladder. Some surgeons simply inject air by means of a catheter and a brass syringe or a Davidson syringe. If air is injected, a rectal bag is not used, and the patient is placed on his back rather than in the position of Trendelenburg. The best method

of injecting air is that of F. Tilden Brown, by means of a bicycle-pump. A catheter is introduced, the bladder is washed out, the catheter is fastened to a bandage, the bicycle-pump is attached, the operation is proceeded with, and when the transversalis fascia is exposed the bladder is filled with air, the soft catheter is clamped, and the bladder is opened.[1] Make a three-inch longitudinal incision in the median line of the hypogastric region, terminating over the symphysis. When the perivesical connective tissue is reached, cut it. If the peritoneum should appear, push it up. Hold the wound-

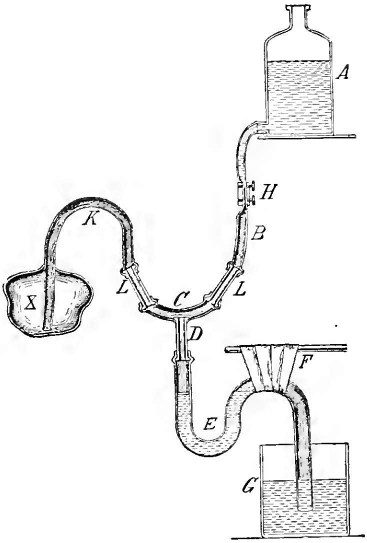


FIG. 384.—Keen's modification of Cathcart's siphonage apparatus: *X*, cavity to be drained; *A*, reservoir; *K*, tube from cavity; *B*, tube from reservoir; *H*, clamp on tube from reservoir; *L*, *L*, *D*, glass tubes; *C*, rubber tube connecting cavity-drain with reservoir-drain; *E*, S-shaped rubber tube maintained in shape by hooking up at *F*; *G*, vessel containing antiseptic fluid.

edges apart with retractors. The large veins are seen, giving the bladder a blue color. Avoid these veins if possible, but even if they should be cut bleeding will usually cease when the bladder is opened and the rectal bag is removed. Clamp bleeding vessels; catch the bladder transversely with a tenaculum at the upper angle of the wound; open the viscus in the middle line above, and cut toward the pubes; catch the edges of the bladder with hemostatic forceps, and remove the tenaculum. Explore the bladder, remove the stone or stones, scrape away incrustations, ligate bleeding vessels outside the

[1] F. Tilden Brown, *Annals of Surgery*, Feb., 1897.

bladder, and irrigate the viscus with hot saline solution. Introduce a tube into the bladder, and attach to its external end a long tube to siphon off the urine. The bladder can be drained very satisfactorily by Keen's siphonage apparatus (Fig. 384). Suture the muscles and fascia at the upper part of the wound. Dress with dry antiseptic gauze and a rubber-dam, the dressings and binder being split to go around the tube. Catch the urine which siphons over in a bottle containing some antiseptic fluid. Change the dressings as often as they become wet. Take out the tube in four or five days, and allow the wound to heal by granulation. The patient may get up in two weeks. Many Continental surgeons advocate immediate suture of the bladder after incision. The suture-material should be silk or catgut. Albert, Vincent, Bassini, DeVlaccos, and others advocate immediate suture. After suture a catheter is kept in the bladder to drain the viscus. Immediate suture may be employed in patients of any age, but should not be used if the urine is very septic or if pyelonephritis exists. In some cases the attempted closure will fail; in others it will only partially succeed; in many it will prove successful; but even if it only partially succeeds it will tend to prevent dissemination of urine in the prevesical cellular tissue. The chief causes of death after suprapubic lithotomy are septicemia, secondary hemorrhage, cellulitis, peritonitis, and suppression of urine. J. W. White estimates the relative mortality of suprapubic and lateral lithotomy as follows:

In children the suprapubic operation gives a mortality of 12 per cent., the perineal of 3 per cent. In adults the suprapubic gives a mortality of 12 per cent., the perineal from 8 to 12 per cent. In old men the suprapubic gives 25 to 30 per cent., the perineal 30 to 40 per cent.

Crushing of Vesical Calculi.—This is now done in one sitting, the old operation of Civiale, which required repeated crushings, being obsolete.

Litholapaxy (Bigelow's operation, or rapid lithotrity) is the operation for removing a stone in the bladder in one sitting by thoroughly crushing the stone and completely washing away the fragments. This operation is wonderfully successful if done by an expert. Few of us do it sufficiently often to learn how to perform it with great rapidity, certainty, and safety. It is the best operation in most cases, if performed by a very skilful man. It is the operation in most every case for even the general surgeon to select, but the general surgeon will have better results in certain difficult cases

after suprapubic lithotomy than after litholapaxy. Sir H. Thompson says this method is suited to twenty-nine cases out of thirty. Litholapaxy should be employed if the bladder will hold at least six ounces of fluid and is in a fairly healthy condition; if the urethra is tolerant and penetrable by instruments; if the stone is not too hard, does not weigh over two and three-quarters ounces, and is not over two inches in diameter. It is not suited for multiple calculi, for large and hard calculi, for encysted stones, or for a patient with enlarged prostate, with vesical atony, or with cystitis. An easily dilatable stricture need not prevent the sur-

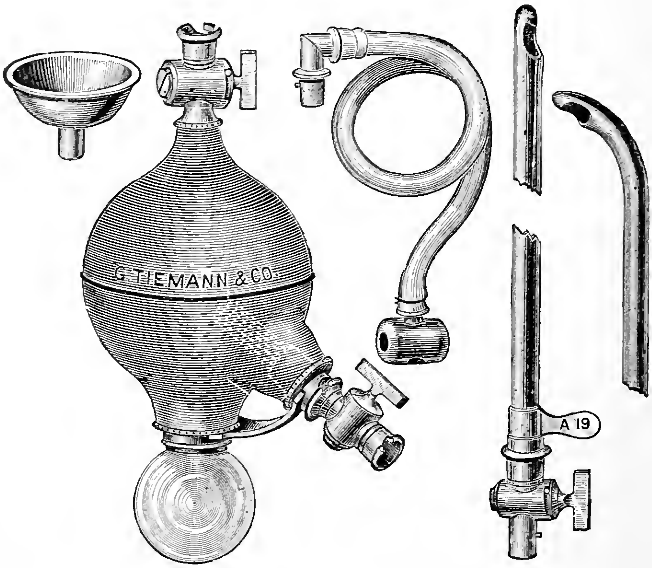


Fig. 385.—Bigelow's latest evacuator.

geon doing litholapaxy. The stricture can first be dilated, and later Bigelow's operation can be performed, but firm, gristly strictures demand a cutting operation. If the urethra is intolerant of instrumentation, the patient being prone to febrile attacks when it is attempted, cut instead of crushing. An individual laboring under kidney disease will do better after this operation than after cutting (Cage). In diabetes, locomotor ataxia, and conditions of exhaustion patients are best treated by Bigelow's operation, unless cystitis exists.

The Indian surgeons have had the most admirable results

from litholapaxy. It has often been claimed that such results were due to racial peculiarities of the patients and various factors regarding their habits, diet, etc. The fact, however, that some of these very surgeons have returned to England and repeated their successes in London, shows how large a part dexterity played in obtaining success.

J. A. Cunningham[1] reports upon 10,073 Indian cases of litholapaxy. The mortality was 3.96 per cent.

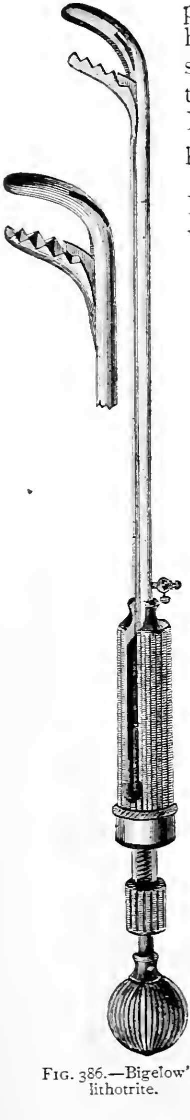


FIG. 386.—Bigelow's lithotrite.

FIG. 387.—Thompson's lithotrite.

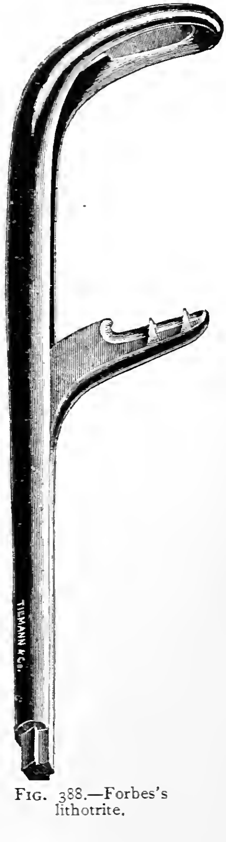


FIG. 388.—Forbes's lithotrite.

Cabot of Boston in 116 cases had but four deaths, and two of these were due to pneumonia.

[1] *Brit. Med. Jour.*, August 7, 1887.

The preparation of the bladder is the same as for lithotomy. Be sure to measure the stone, and to ascertain also whether a lithotrite can readily be introduced and manipulated. The instruments required are a stone-sound, lithotrites (several sizes, Figs. 386–388), an evacuating-bulb and tubes (straight and curved, Figs. 385, 389), soft catheters, a glass irrigator to inject the bladder, and instruments in case the surgeon is forced to cut. The patient is anesthetized and is placed upon his back, a pillow is inserted under the pelvis and he is well wrapped up. The urine is drawn and a measured amount of warm boric acid is allowed to flow into the bladder. This plan is better than having the patient retain his urine, as in the latter case there is no certainty as to the amount of fluid in the viscus. It is well to introduce at least five or six ounces of fluid if possible. If the bladder will not hold four ounces the operation is unsafe (Thompson). The lithotrite, preferably the instrument of Forbes (Fig. 388), is now introduced, the handle being gradually raised to a vertical position as the penis is drawn up on the shaft, but not being depressed until the instrument has passed by its own weight into the prostatic urethra. Thompson's plan for catching the stone is as follows: after introducing the lithotrite, let its lower end rest for a few seconds on the bottom of the bladder, so that currents will subside; then draw back the male blade, wait a moment, close the blades, and in almost every instance the stone will be caught. If the stone is caught, press firmly to see that the calculus is well held, lock the instrument, and break the foreign body by screwing. When resistance suddenly ceases the stone has either slipped or has been crushed; if crushed, the blades should have been felt forcing through the stone and the calculus should have been heard to break. When

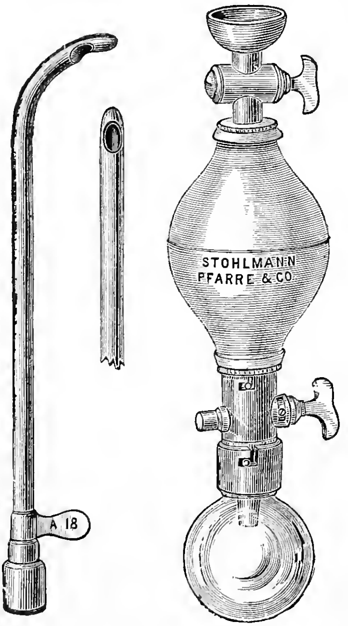


FIG. 389.—Thompson's evacuator.

resistance ceases catch and crush again as above directed. Rapid movements with the lithotrite are improper, as they establish currents which are apt to push away the stone. If the above maneuver does not catch the stone, see if the calculus be near the neck of the bladder. Pull the instrument close to the vesical neck, and open it, not by pulling the male blade, but by pushing the female blade. If the operator still fails to catch the stone, or if, after crushing, a large fragment knocks against the evacuator, which fragment cannot pass, conduct a careful search: turn the blades to the right side, open, and close; then to the left side, open, and close; next turn the point around behind the prostate, open, and close. After making a side search with the lithotrite, turn the instrument very slowly, so as to detect the catching of the bladder-wall if it has occurred, and crush the stone in the middle of the bladder with the blades up. After crushing several times, proceed to evacuate. Fill the aspirator with warm saline fluid. Insert an evacuating catheter, its point being in the center of the bladder, let the fluid and fragments run out, and attach the aspirator to the catheter; turn the valve, and compress and relax the bulb so that an ounce or more of fluid is forced in at each squeeze, the compression coinciding with expiration. The débris falls into a bulb, and the pumping is continued until fragments cease to pass, whereupon the point of the catheter is pushed against the floor of the bladder and another trial is made. If fragments which cannot gain exit are felt knocking against the tube, withdraw the evacuator, crush again, and again use the aspirator. When no more débris comes away and no more fragments are felt, withdraw the tube and carefully sound the bladder. Keyes advises the operator to seek for a final fragment by listening with a stethoscope while pumping at the bulb and searching the bladder with the tube. This operation will rarely occupy over forty minutes, though Bigelow has protracted it for three hours, the patient recovering. A serious complication is severe bleeding, due to damage done with the instrument or to the presence of a tumor which easily bleeds. The injection of moderately hot water usually checks hemorrhage, but if bleeding is dangerous in amount the operation of litholapaxy should be abandoned and a suprapubic lithotomy be performed.

If clogging of the lithotrite with fragments occurs, forcible pushing of the blades together repeatedly will probably amend it; but it will never happen if the surgeon uses a proper form of instrument. A lithotrite with a

fenestrated blade will not lock. Forbes's lithotrite is a very powerful instrument, the blades of which will not lock. If the blades of a lithotrite should become forcibly and hopelessly locked, make a perineal section, clear out the blades, close them, and then withdraw the instrument.

After-treatment.—Put the patient to bed, apply a bag of hot water to the hypogastrium, and give him a hypodermatic injection of morphin as he recovers from ether. Give a hot hip-bath every night, and administer liquor potassii citratis in moderate doses every day. If urethral fever occurs, use quinin and morphin, wash out the bladder several times daily with warm boric-acid solution, and tie in a rubber catheter. If retention occurs use the catheter. If cystitis appears, treat as in an ordinary case. The urine ceases to be bloody in two or three days, and the patient may get up in a week.

Litholapaxy in Male Children.—It was considered until quite recently that a child, because of the small size of its bladder, the small diameter of the urethra, and the readiness with which the mucous membrane is lacerated by even slight violence, was a bad subject for crushing. Lateral lithotomy is known to be eminently successful when performed upon children. The elder Gross did this operation upon 72 children with only 2 deaths. Keegan, however, has persuaded the profession that rapid lithotrity is perfectly applicable to children: he shows that the bladder of a child of even less than two years of age is quite large enough to allow the surgeon to manipulate an instrument, that the mucous membrane is in no danger if the operator be careful, and that the urethra is by no means so small as was supposed. The urinary meatus must often be incised, and after doing this, Keegan states, there can be passed in a boy of from three to six years a No. 7 or 8 lithotrite (English), and in a boy of from eight to ten years a No. 10 or even a No. 14. It is, however, just to state that the operation is more delicate than a like procedure on older persons, and that no one is justified in doing it who has not had considerable experience in adult cases. Furthermore, it should be noted that Keegan's mortality by this operation has been 4.3 per cent., while Gross's mortality from lateral lithotomy on children was 2.67 per cent.

Special points of litholapaxy on male children are as follows: use well-fenestrated lithotrites; have a stylet to punch out the fragments blocking the evacuator; and crush the stone to a fine mass. There can usually be employed a No. 8 lithotrite and a No. 8 evacuating-tube.

Perineal Lithotrity (Keith's Operation).—This operation is employed by some surgeons in dealing with very hard or very large calculi in male adults, or in cases in which it is impossible to introduce a lithotrite into the bladder. Keith's operation consists in opening the urethra from the perineum, passing a lithotrite through the wound, into the urethra and along the urethra into the bladder, and crushing the stone, introducing an evacuator and removing the fragments. In Keith's operation the incision is median, and opens the membranous urethra. In very large stones, Milton thinks the surgeon should open the bladder as in ordinary lateral lithotomy, introduce a lithotrite through the incision, and crush the stone before extracting it, thus avoiding the infliction of injury upon important structures.

Operation for Stone in Women.—If the stone be small, give the patient ether, place her in the lithotomy position, dilate the urethra with the uterine dilator until it admits the index-finger, and remove the stone with the finger, the scoop, or the forceps. If the stone is found to be too large to pass, crush it with a lithotrite and get rid of the débris by the evacuator. Large stones (two ounces) may require suprapubic lithotomy. Vaginal lithotomy is never required. If done, it is very likely to leave as a legacy a vesicovaginal fistula. In female children dilate the urethra, crush the stone, and evacuate.

Cystotomy.—This term means the opening of the bladder, and it is usually applied to an opening made for drainage, for diagnosis, for the removal of stones or tumors, or for the treatment of ulcers. This opening may be done by (1) a suprapubic cut (as in suprapubic lithotomy), (2) a lateral perineal cut (as in lateral lithotomy), or (3) a median perineal cut (as in median lithotomy).

The operation may be completed in one sitting, or the bladder may be only exposed, the opening of it being delayed for several days until it becomes adherent to the margins of the wound (Senn's operation). Senn's operation prevents infiltration of urine into the prevesical space, and it is advisable to select it if the urine is very foul.

A sinus may persist after suprapubic cystotomy, but usually the wound heals unless it is kept open by some expedient.

The effects of suprapubic drainage are very beneficial in cases of chronic cystitis associated with hypertrophy of the prostate gland, the urine being foul. Drainage causes the

urine to become clear and the mucous membrane of the bladder to become normal. If the opening is made as a permanent drain, there will usually be incontinence, as the new channel has no sphincter action (Dandridge).

Suprapubic Cystotomy.—The operation is employed to allow the surgeon to explore the bladder, to treat an ulcer, to provide drainage, or to remove a tumor. If the operation is for calculi, it is known as suprapubic lithotomy

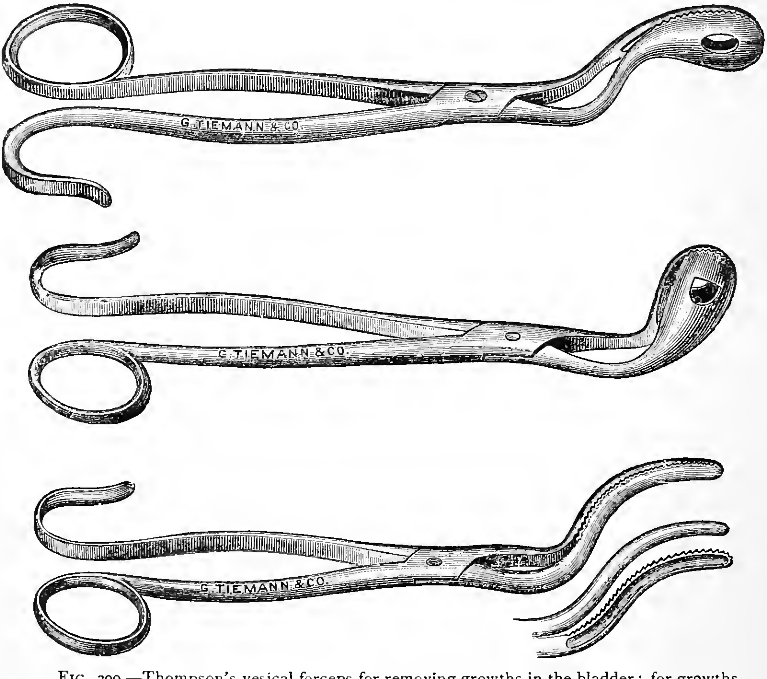


FIG. 390.—Thompson's vesical forceps for removing growths in the bladder: for growths close to the neck of the bladder, with separation of the blades, to avoid nipping the neck of the bladder.

(page 983). After the bladder is opened its interior can be illuminated by the rays of an electric lamp, which appliance is fastened with a mirror to the forehead of the operator. The operation is described on page 983. If an ulcer is found, it is scraped with a curet or a spoon. Most cases of tumor require suprapubic cystotomy. It is true that a small single growth at the vesical neck is accessible by median cystotomy, but the area for manipulation is very narrow and the

growth cannot be seen. Every large growth, all cases of multiple tumors, and all cases of tumor in individuals with great depth of perineum or with enlarged prostate require

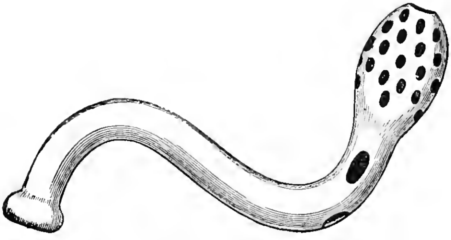


FIG. 391.—Senn's silver tube.

suprapubic cystotomy, an operation which allows one to feel and to see the growth, which gives room for manipulation, and which permits thorough exploration of the entire blad-

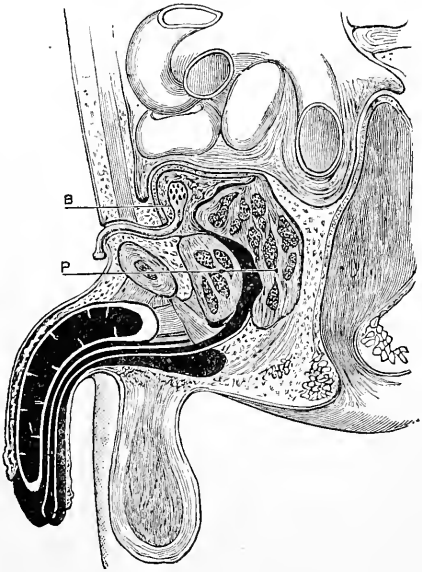


FIG. 392.—Senn's tube applied. The instrument does not press upon the sensitive neck of the bladder.

der. The patient is put in the Trendelenburg position if water distention is used, but is placed horizontally if air distention is employed. After opening the bladder as for stone (page 983) hold the edges of the incision apart by

means of a speculum (speculum of Keen or Watson) or with retractors, and reflect the electric light into the wound. Growths when seen can be twisted off, a pair of forceps holding the base and another pair being used to twist. Broad growths should be transfixed, ligated, and severed. Some growths (as cancer) are removed piece by piece with Thompson's forceps (Fig. 390), the base of the tumor being scraped. Soft growths are scraped away with a curet, a spoon, or a finger-nail. If bleeding is severe, check it by pressure, by iced water, or even by the actual cautery. In some cases the wound is allowed to heal rapidly. In others the bladder is drained for a considerable time. In some it is kept open permanently. Permanent drainage is desirable in some cases of enlarged prostate, and in such cases Senn's tube is very useful (Fig. 391).

Median Cystotomy.—The same incision is made in the perineal raphé in median cystotomy as for median lithotomy. A grooved staff is introduced and is hooked up under the pubes; an incision is made into the membranous urethra, and is extended backward for three-quarters of an inch, and a finger is carried into the bladder. If searching for a growth, find it with the finger, catch it with Thompson's forceps, and twist it off. Soft growths can be scraped away. Stop bleeding by digital pressure or by injections of iced water. If median cystotomy does not allow access to the tumor, perform suprapubic cystotomy.

Growths in the Female Bladder.—Dilate the urethra as in a case of stone, and scrape, twist, or pull the growth away or ligate it. If the growth is large or if there are multiple growths, perform suprapubic cystotomy.

Diseases and Injuries of the Urethra, Penis, Testicles, Prostate, Seminal Vesicles, Spermatic Cord, and Tunica Vaginalis.

Injuries of the penis and urethra may arise from traumatism to the perineum or the penis, from cuts and twists of the penis, from the popular "breaking" of a chordee, from tying strings around the organ, from forcing rings over it, from the passage of instruments, or from the impaction of calculi. Violence inflicted upon an erect penis may fracture the corpora cavernosa. The writer saw one man with a glass rod broken off in the canal, he having been in the habit of introducing it at the dictate of morbid sexual excitement. A patient in the Insane Department of the Phila-

delphia Hospital pushed a ring over his penis, which organ was lacerated into the urethra. These injuries are treated on general principles.

Perineal Bruises.—If the perineum be bruised without rupture of the urethra, the perineum and scrotum swell and become discolored; water is passed with difficulty because the extravasated mass of blood in the peri-urethral tissues occludes more or less the canal; the water is not bloody; and there are pain and profound shock. Some authors designate as rupture those cases in which laceration of the spongy tissue occurs, without involvement of the mucous membrane or of the fibrous coat, but they are properly contusions.

Treatment.—Place the patient in bed and establish reaction, and when reaction is complete employ opiates for the relief of pain. Apply an ice-bag to the perineum. If, notwithstanding these measures, swelling continues, introduce a silver catheter (No. 12 English), tie it in, and make pressure upon the perineum by a firmly-applied T-bandage or by a crutch braced against the foot-board of the bed. Even when swelling is slight, retention of urine may occur from projection of a submucous blood-clot into the canal of the urethra. In some cases it may become necessary to incise and evacuate the blood-clot. After twenty-four hours have passed, if hemorrhage has ceased, substitute a hot-water bag for the ice-bag, and empty the bladder regularly with a soft catheter. Occasionally, though rarely, an abscess forms. *Punctured wounds of the urethra* require ordinary dressings. *Incised wounds of the urethra*, when longitudinal, are closed by suture. Healing is rapid, and ill consequences are not to be feared. Stricture does not follow. When the wound is transverse, introduce a catheter, suture the wound over the instrument, and remove the catheter at the end of the third day. If a catheter cannot be introduced, employ sutures, but at the first evidence of extravasation open the wound, and if drainage is not free perform an external perineal urethrotomy.

Rupture of the Urethra.—By this term is meant a lacerated or a contused wound of the urethra, destroying partially or entirely the integrity of the canal. A lacerated wound may be induced by fracture of the cavernous bodies during erection, the symptoms being severe hemorrhage, intense pain, retention of urine, and inability to pass an instrument; infiltration of urine occurs, and gangrene is a common result. The writer has seen one case of rupture of the penile urethra due to a man's slipping while shaving,

the penis being caught in a partially open drawer, the drawer being shut by his body coming against it. Rupture, however, is almost invariably located in the perineum, and it arises when the urethra is suddenly and forcibly pressed against the arch of the pubes by a blow, by a kick, or by falling astride a beam or a fence-rail. The lesion of urethral rupture consists in some cases of laceration of the spongy tissue and the mucous membrane, a cavity being formed which communicates with the canal, and which fills with urine during micturition. In other cases not only the spongy tissue and the urethral mucous membrane are rent asunder, but the fibrous coat is also torn, the canal opening directly into the perineal tissues, among which a huge cavity forms, that fills with blood and later with urine and pus. The urethra may be torn entirely across, but in most cases a small portion at least of its circumference is uninjured. Rupture never occurs primarily and alone in the prostatic urethra; it is extremely rare in the membranous urethra unless due to pelvic fracture; and it is very unusual in the penile urethra. The seat of rupture in the great majority of cases is in the region of the bulb. Very rarely is the skin broken. Retention of urine due to stricture may lead to extravasation of urine.

Symptoms.—The symptoms of rupture of the urethra are considerable pain, aggravated by motion, pressure, and attempts to pass water; great shock; in some cases micturition is still possible, blood preceding and also discoloring the stream, for some blood usually runs into the bladder; retention of urine quickly arises; in a vast majority of the cases retention is absolute from the very first, and it is due to the interruption in the integrity of the canal and to the occlusion of the channel by blood-clots. Bleeding, which is usually free, lasts for several hours, some little blood generally appearing externally and much being retained in the perineum, inducing progressive swelling. The presence of a large swelling is regarded as evidence of urethral rupture. The blood which is effused in the perineum may extend under the fascia to the penis and scrotum. The swelling soon becomes reddish, purple, or even black, pressure upon it is apt to cause blood to run from the meatus, and it is augmented in volume when attempts are made to urinate. After a time, if the surgeon does not act, the urine fills the perineal cavity and widely infiltrates, and there ensue gangrene, sloughing, and sepsis, life being endangered or fistulæ being left as legacies. The course of the extravasated

urine will often enable one to locate the seat of injury. In rupture of the membranous urethra, if uncomplicated, the urine remains between the two layers of the triangular ligament until a channel is opened for it by sloughing or by the knife. When extravasation occurs behind the posterior layer of the ligament the urine finds its way to the perineum in the neighborhood of the anus. When the rupture is in front of the anterior layer of the ligament the urine, directed by the deep layer of the superficial fascia, finds its way into the scrotum and up on the belly, but does not pass into the thighs. A contusion is distinguished from a rupture by the facts that in the former the perineal swelling is not very extensive and does not enlarge on attempting micturition, while in the latter it is extensive and does enlarge on attempting to pass water. Furthermore, contusion does not cause urethral hemorrhage, while rupture does. A contusion sometimes, but not often, prevents the passage of a catheter; a rupture almost always, but not invariably, does so. The mortality from severe rupture with extravasation is about 14 per cent. (Kaufman).

Treatment.—In some cases it is possible to suture the urethra, and this procedure should be carried out when possible. In order to suture, perform suprapubic cystotomy and also make a perineal section. Find the posterior end of the ruptured urethra by passing a catheter from the bladder into the urethra. Suture with silk. The sutures pass through all of the coats of the urethra. The roof of the canal is sutured first, then a steel sound is introduced from the meatus, and the urethra is sutured around the instrument. The sound is withdrawn and the bladder is drained by Cathcart's siphon as modified by Keen.[1] In recent cases of ruptured urethra the usual treatment is as follows: immediately perform perineal section and turn out the clot; trim off lacerated edges; find the proximal end of the urethra, pass a catheter from the meatus into the bladder, and leave it *in situ* until healing has begun around it. When rupture occurs back of a stricture it is a good plan to excise the cicatricial tissue. In cases with extravasation lay open freely all pockets of urine and proceed as above. If the proximal end of the urethra cannot be found, either open the bladder by Cock's method of perineal section without a guide, cutting toward the apex of the prostate gland and carrying the incision forward into the rent, or perform a suprapubic cystotomy with retrograde catheterization; that is, push an instrument from the bladder

[1] See Weir's report in *Medical Record*, May 9, 1896.

into the wound, and use it to guide a catheter passed from the meatus into the bladder. The wound is packed with iodoform gauze, and the bowels are tied up with opium for a few days. Many surgeons strongly disapprove of the custom of retaining the catheter, believing that the instrument does no real good, as urine is certain to get between the catheter and the walls of the urethra. In fact, it is quite enough to stuff the wound with gauze, the patient urinating through the wound for the first few days, after which time a catheter is used at regular intervals. Whatever method is employed, healing will require from six to eight weeks, and the patient must during the rest of his life, from time to time, introduce large-sized bougies.

Foreign Bodies in the Urethra.—These bodies may be calculi, bodies introduced by injury, as shot, bone, etc., bodies entering from a fistulous opening into the rectum, or bodies introduced from the meatus, as broken bits of catheters, straws, pins, etc.

The **symptoms** vary with the size and the nature of the body. Sometimes there are almost no symptoms; at other times there are found great pain, retention of urine, and hemorrhage. Examination is made by feeling carefully with a finger in the rectum and by searching very gently with a sound, taking care not to push the body back. If the bladder is well filled with water when the body becomes impacted, inject a little oil into the meatus, close the lips with the fingers, and direct the patient to forcibly attempt urination, the surgeon opening the meatus when the urethra is widely distended, the foreign body being often forced out. If this maneuver fails, and the foreign body is impacted in the pendulous urethra, prevent its backward passage by at once tying a rubber tube around the penis. Try to squeeze the body out, and, if unsuccessful, endeavor to catch it with a wire loop, with a scoop, or with the long urethral forceps. If these methods fail, cut down upon the body and remove it, dividing any existing stricture. If a hairpin is in the canal, the feet of the pin are almost always pointing to the meatus; to prevent them catching on attempted withdrawal, the penis must be squeezed to approximate the feet, and when they are adjacent a part of a silver catheter is slipped over to retain them in this position, when the pin can be extracted. If this fails, drag the penis against the belly, by rectal touch force the sharp ends out through the integument, cut one end off, and then withdraw the other. An ordinary large-headed pin is forced out in the same way,

and when the head is turned externally it is extracted from the meatus. If a lithotrite loaded with fragments be caught in the urethra, the surgeon must perform a perineal section, clean and close the blades, and withdraw the instrument.

Urethrorrhea is not urethral inflammation, but is a condition of sensitiveness of the urethra and oversecretion of the glandular elements. It may be due to masturbation, sexual excess, and also, as Sturgis points out, to withdrawal during sexual intercourse, and to ungratified sexual passion. A drop or two of transparent mucus is found at the meatus in the morning, and a considerable amount may flow away while straining at stool or upon the diminution of an erection. This flow at stool is often called defecation spermatorrhea. This discharge stains but does not stiffen linen (Sturgis). The discharge contains mucus, mucous corpuscles, epithelial cells, sometimes spermatozoids, but no gonococci or pus organisms. The patient may be well in all other respects; there may be neurasthenic symptoms, sexual weakness, or even impotence.

Treatment.—In an uncomplicated case improvement or cure will follow upon the abandonment of evil habits. If complications arise, they must be treated.

Urethritis, or Inflammation of the Urethra.—Urethral inflammations can be divided into two classes: (1) *simple*, in which infection is due alone to pyogenic cocci, and (2) *specific*, in which the gonococcus is present.

Simple urethritis may be due to several causes, such as traumatism; great acidity of the urine; chancre in the urethra; contact with menstrual fluid, leukorrheal discharge, the discharge from malignant disease of the uterus, ordinary pus, or acrid vaginal discharge; the passage of instruments; the administration of irritant diuretics; strong injections; worms in the rectum; a febrile malady; venereal excess and masturbation; and the passage or impaction of foreign bodies. A temporary and mild urethritis sometimes accompanies early syphilitic eruptions. Simple urethritis is less severe and prolonged than gonorrheal urethritis, though clinically in the early stage the physician cannot invariably distinguish between the two forms. The gonococcus is never found in the discharge of simple urethritis. In the non-specific inflammation pus is not always present, many cases stopping short of pus-formation after a varying period of catarrh, but any catarrh may become purulent. A simple urethritis may be caused or may be prolonged for

an indefinite period by the presence of large amounts of oxalate in the urine or the existence of the uric-acid diathesis (see Gouty Urethritis).

Treatment.—Seek for the cause and remove it. Correct any abnormal condition of the urine by means of suitable diet, drugs, and mode of life. Mild astringent injections are useful. It may be necessary to flush the urethra repeatedly with a solution of silver nitrate (1 : 8000).

Traumatic Urethritis.—The pain in traumatic urethritis is coincident with the introduction of the foreign body. The discharge, which may be bloody, mucous, mucopurulent, or purulent, comes on within twenty-four hours.

Treatment.—If the inflammation is slight, prescribe diluent drinks, paregoric, and a saline. If severe, put the patient to bed, apply hot fomentations to the perineum, give diluent drinks, employ suppositories of opium and belladonna, and watch for fever and other complications.

Gouty Urethritis.—This condition first manifests itself in the posterior urethra, not in the anterior, as does clap. Its symptoms are great vesical irritability; pain on urination; discharge usually scanty, associated with uric acid in the urine or other symptoms of gout. The *treatment* comprises dieting and the usual remedies for gout. Purgatives are given freely, and full doses of colchicum, piperazin, urotropin, or the alkalies; hot baths, low diet, diluent drinks, and diaphoretics are indicated. A chronic discharge from the prostatic region is apt to linger; for this there is nothing better than the usual gouty remedies and saline waters with copaiba, cubebs, or sandalwood oil. In many cases it is necessary to flush the urethra once a day with a solution of silver nitrate (1 : 8000).

Eczematous Urethritis.—Berkley Hill states that this disease is very obstinate, is probably associated with gout, and is met with in adults of full habit or who are beer-drinkers and who have eczema of the surface of the body. He states also that the glans penis near the meatus is red and tender, and that the interior of the urethra is in the same condition. Pain is constant, and it is aggravated on micturition. The discharge is scanty. The *treatment* comprises injections of cold water or irrigation with iced water, and internally the administration of arsenic with the alkalies.

Tubercular urethritis is due to a tubercular ulcer, which is most apt to be seated near the vesical neck. There is a little pain on micturition, but there is intense pain at one spot on passing a bougie. The discharge is slight and at

times bloody. The bladder is very irritable, and severe cystitis arises and persists. The *treatment* includes warmth, good food, and cod-liver oil, removal to an equable climate, and living as much as possible out of doors. The bladder is washed out once a day with boric-acid solution. Iodoform emulsion is injected daily, but after a time the surgeon will be forced to drain by perineal or suprapubic cystotomy.

Gonorrhea (Clap; Specific Urethritis; Tripper; Venereal Catarrh).—Gonorrhea is an acute inflammation of the genital mucous membrane, of venereal origin, due to the deposition and multiplication of gonococci in the cells of the membrane and a mixed infection with the cocci of suppuration. In the male, clap begins within the meatus and fossa navicularis and extends backward throughout the length of the urethra. The mucous membrane swells and becomes hyperemic, and there is a discharge, first of mucus and serum, and then of pus. In severe cases the discharge is bloody (black gonorrhea). For a week or more the inflammation increases, then becomes stationary for a time, and then declines, the discharge growing less profuse and thinner, a watery discharge lasting for some little time. An ordinary case of genuine gonorrhea lasts from six to ten weeks, and even a case limited purely to the anterior urethra will rarely be cured within four or five weeks. During the acute stage the entire penis swells and the corpus spongiosum becomes infiltrated with inflammatory exudate. Gonorrhea may produce systemic complications and tends particularly to attack serous membranes or other endothelial structures (joints, pericardium, pleura, tendon-sheaths, intima of vessels, etc.).

Gonorrheal rheumatism is discussed on page 530. Gonorrheal peritonitis is rare. Infection of the peritoneum through the blood is very rare. The majority of cases of gonorrheal peritonitis occur in women and are due to direct extension from the Fallopian tubes. Gonococci have not been found in the exudates of cases of pleuritis and pericarditis supposed to be of gonorrheal origin. Gonococci have never been found in meningitis. True gonorrheal septicemia occasionally occurs. In one case Blumer and Hayes found the organisms in the blood.

Symptoms of Acute Inflammatory Gonorrhea.—The period of incubation of gonorrhea is from a few hours to two weeks. The patient notices on arising a drop of thin fluid which glues together the lips of the meatus, and he feels some pain on urination. The meatus is red and swollen.

Within forty-eight hours the *first stage*, or the stage of increase, becomes established. The meatus is now red, swollen, and everted (fish-mouth meatus); micturition causes severe pain (ardor urinæ); chordee occurs, especially when the patient is warm in bed. By chordee we mean a condition of painful erection in which the penis is markedly bent. The rigid infiltration of the corpus spongiosum prevents it distending to accommodate itself to the enlarged corpora cavernosa, and in consequence the organ curves. There is frequent micturition with tenesmus, and a profuse discharge which is yellow, greenish, or even bloody. The complications of this stage are *balanitis* (inflammation of the mucous membrane of the glans penis), *balanoposthitis* (inflammation of the surface of the glans and the mucous membrane of the prepuce), *phimosis* (thickening and contraction of the foreskin so that the glans cannot be uncovered), and *paraphimosis* (catching and fixation of the retracted prepuce behind the corona glandis). In the *second* or *stationary stage*, which lasts from the end of the first to the end of the second week, the acute symptoms of the first stage continue. The complications of this stage are peri-urethral abscess, lymphangitis, solitary and painful bubo of the groin which may suppurate, inflammation of Cowper's glands, inflammation of the prostate or of the bladder, and gonorrheal ophthalmia. In the *third* or *subsiding stage* the symptoms gradually abate, the discharge becoming scantier and thinner, and finally drying up. This stage is of uncertain duration, and in it there may occur *epididymitis*, or inflammation of the epididymis. Among other possible complications we may mention gonorrheal arthritis (page 530), infective endocarditis, tenosynovitis, pyelitis, perichondritis, and peritonitis. Every urethral discharge should be examined for gonococci in order to make a positive diagnosis. This examination is made several times during the progress of the case, so as to determine when the organisms disappear. The examination can be easily made. Place a drop of discharge upon a cover-glass, lay another cover-glass over this, and slide the glasses apart. Dry the slides in the flame of an alcohol lamp. Bring the cover-glasses in contact with a saturated solution of methylene-blue in 5 per cent. carbolic-acid water. The staining-material is allowed to remain in contact with the slides for five or ten minutes, the glasses are washed with water, are then placed in a solution of 5 drops of acetic acid to 20 c.c. of water, and kept there "long enough to count one, two, three slowly," and again washed with water. Ex-

amination with the microscope shows the gonococci stained blue.[1]

Subacute or catarrhal gonorrhea develops in men who have previously had gonorrhea, as a result of prolonged or repeated coition or of contact with menstrual fluid or leukorrheal discharge. There is profuse mucopurulent discharge, very little pain on micturition, rarely chordee or marked irritability of the bladder.

Irritative or Abortive Gonorrhea.—In this disease the symptoms, which are identical with those of beginning clap, do not increase, but are apt to disappear within ten days.

Chronic Urethral Discharges.—Chronic Urethral Catarrh, which may follow gonorrhea, is characterized by the occasional presence of a drop of clear, tenacious liquid. This discharge becomes more profuse as a result of sexual excitement or the abuse of alcohol.

The persistence of a small amount of milky discharge, because of localization of inflammation in one spot or the production of a granular patch or a superficial ulcer, characterizes chronic gonorrhea. There is some scalding on urination; erections produce aching pain; there are pain in the back and redness and swelling of the meatus. All the symptoms are intensified by sexual excitement, by coitus, by violent exercise, or by alcoholic excess.

Gleet.—If a chronic urethritis lasts over ten weeks, it is called gleet. In gleet the lips of the meatus are stuck together in the morning, and squeezing them discloses a drop of opalescent mucopulent fluid. During the day the discharge is rarely found. There are frequency of micturition, pains in the back, and dribbling of urine, and a bougie will usually find a stricture of large caliber. A discharge may be maintained by *chronic prostatitis.* In this condition there are frequency of micturition; a sense of weight or dull pain in the perineum; diminished projectile force of the stream of urine; there is often a tendency to sexual excitement and premature emission. In chronic anterior urethritis there is a discharge from the meatus or sticking together of the lips in the morning. In chronic posterior urethritis there is no discharge of pus from the meatus. If two beaker glasses are placed upon a stand and the patient is directed to urinate first in one and then in the other, if he suffer from chronic anterior urethritis, only the first portion will be cloudy and show shreds; if he suffers from posterior urethritis of not

[1] Schütz's method, as set forth by R. W. Taylor in his work upon *Venereal Diseases.*

very long standing, both portions will be a little clouded, the first containing clap shreds, the second hook-shaped shreds. In a very chronic case neither sample will be cloudy, but the first portion will contain shreds.

Treatment of Acute Gonorrhea.—*Abortive treatment* may be tried if the case is seen early. The writer formerly believed that by cleansing the urethra several times a day with peroxid of hydrogen, following the hydrogen by the injection of oil of cinnamon and benzoinol, many cases of gonorrhea could be quickly aborted. Further observations confirmed by bacterial investigation have shown that he was in error. True gonorrhea cannot be aborted by the above-mentioned plan. Other abortive methods are the use of hot retro-injections of corrosive-sublimate solution (1 : 20,000), two pints being run through the urethra once a day; strong injections of nitrate of silver or of tannin; scraping the meatus or the urethra adjacent with cotton, and injecting 15 drops of a 3 per cent. solution of nitrate of silver. If in seventy-two hours the symptoms are not greatly improved, abortive treatment should be abandoned. Recent studies render it almost certain that there is no real abortive treatment. Abortive treatment, to be efficient, would have to be carried out before the gonococci penetrated the epithelial cells; in other words, would need to be instituted before the symptoms of the disease appear. Janet says that we must alter our conception as to what constitutes abortive treatment, and he doubts if a case of true gonorrhea was ever really aborted.[1] The method of irrigation with solutions of permanganate of potassium is really a prophylactic treatment. Janet applies his treatment as evidences of trouble present themselves, and before acute symptoms appear, and claims that in most persons the disease can be arrested in from eight to twelve days. The same plan of treatment is useful in a well-developed case.

Janet's method is as follows: an irrigator is filled with a warm solution of permanganate of potassium (1 : 4000). The patient after emptying his bladder is seated upon a chair and his sacrum rests upon the extreme front edge of the chair (Valentine). The reservoir is joined to a glass nozzle by a rubber tube. The nozzle is introduced into the meatus, and the fluid is permitted to run gradually at first, with full force later. In anterior trouble the fluid is allowed to run out of the meatus by the side of the nozzle. The anterior urethra is always irrigated first, the reservoir being two feet above the chair.

[1] *Ann. d. mal. d. org. gén.-urin.*, 1896, p. 1031.

In posterior urethritis, after the anterior urethra has been irrigated, the reservoir is raised from six to seven feet above the bed, the meatus is held tight about the nozzle, and the fluid overcomes the force of the compressor urethræ muscles and bladder sphincter and enters the bladder. If the muscles do not quickly relax, continue the hydrostatic pressure for several minutes, when relaxation will usually occur; but if it does not do so, tell the patient to breathe slowly and deeply, and to make efforts at urination (Valentine). When the bladder is full the tube is withdrawn and the patient micturates. This procedure is practised once or twice a day for five or six days, or even longer, and the strength of the solution is gradually increased up to 1 : 1000. It has been claimed that after one or two weeks of this treatment gonococci permanently disappear in the majority of cases. Fig. 393 shows the irrigator devised by Ferd. C. Valentine. Valentine of New York[1] has constructed the following table, which is of use to a practitioner who wishes to employ irrigations with permanganate of potassium in the treatment of acute gonorrhea:

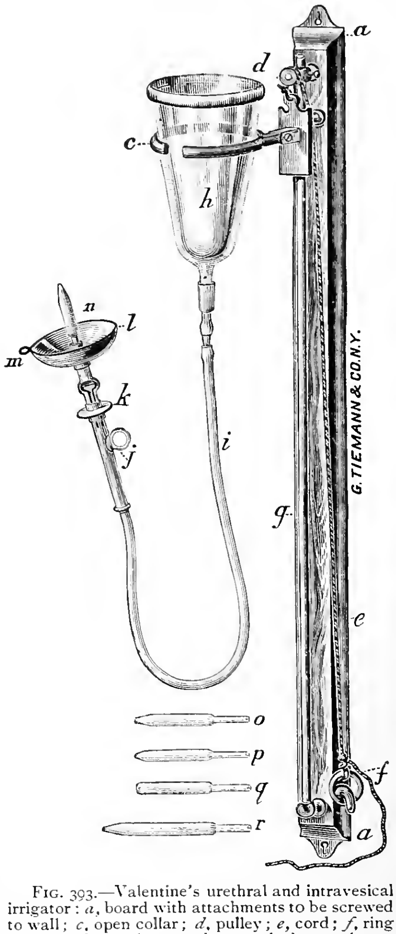


FIG. 393.—Valentine's urethral and intravesical irrigator: *a*, board with attachments to be screwed to wall; *c*, open collar; *d*, pulley; *e*, cord; *f*, ring to suspend percolator; *g*, brass rod; *h*, percolator; *i*, rubber tube; *j*, ring for fourth finger; *k*, flange to graduate pressure; *l*, shield; *m*, ring to suspend shield; *n*, nozzle attached.

[1] *The Irrigation Treatment of Gonorrhea.*

First Day,	first visit.	Anterior irrigation	1 : 3000
First Day,	7 P. M.	Anterior "	1 : 4000
Second Day,	9 A. M.	Anterior "	1 : 3000
Second Day,	7 P. M.	Anterior "	1 : 4000
Third Day,	9 A. M.	Intravesical "	1 : 6000
Third Day,	7 P. M.	Anterior "	1 : 5000
Fourth Day,	9 A. M.	Intravesical "	1 : 5000
Fourth Day,	7 P. M.	Intravesical "	1 : 5000
		Anterior "	1 : 2000
Fifth Day,	Noon.	Intravesical "	1 : 5000
Sixth Day,	Noon.	Intravesical "	1 : 5000
Seventh Day,	Noon.	Intravesical "	1 : 5000
Eighth Day,	9 A. M.	Intravesical "	1 : 5000
		Anterior "	1 : 3000
Eighth Day,	7 P. M.	Intravesical "	1 : 5000
		Anterior "	1 : 2000
Ninth Day,	9 A. M.	Intravesical "	1 : 4000
		Anterior "	1 : 1000
Ninth Day,	7 P. M.	Intravesical "	1 : 4000
		Anterior "	1 : 1000
Tenth Day,	9 A. M.	Intravesical "	1 : 4000
		Anterior "	1 : 1000
Tenth Day,	7 P. M.	Intravesical "	1 : 5000
		Anterior "	1 : 500

For full directions regarding this method see Valentine's excellent book, *The Irrigation Treatment of Gonorrhea.* If a stricture exists, it is not advisable to employ this treatment. Excellent results can be obtained by irrigations with fluid containing silver nitrate (1:12,000 to 1:8000). In treating *a developed case*, order plain, non-stimulating diet and the avoidance of alcohol, sexual excitement, wet, and violent or prolonged exercise. The patient should sleep under light covers and drink much water daily (Seltzer, Apollinaris, or ordinary water containing bicarbonate of sodium). If the foreskin is long, the discharge should be caught by placing bits of absorbent cotton over the meatus and within the prepuce. If the foreskin is short, cut a small opening in a square piece of old linen, slip this linen over the glans, catch it back of the corona, and bring the ends forward with the prepuce. If the glans is completely naked, pin an old stocking-foot upon the undershirt and in it hang the penis. Order a man to wear a suspensory bandage.

Irritative gonorrhea will subside in a few days. The above directions should be followed, and the anterior urethra should be washed out several times daily with peroxid of hydrogen, or irrigated once a day with a hot solution of permanganate of potassium (1 : 4000). In *catarrhal gonorrhea*, at once order injections (1 grain to the ounce of sulphate of zinc; or zinci sulphas gr. viij, plumbi acetas gr. xv, water ℥viij; or gr. v of sulphocarbolate of zinc to ℥j of water; or White's

prescription of ʒj each of acetate of zinc and tannic acid, ʒiij of boric acid, ℥vj of liq. hydrogen. peroxid.). For injecting use a blunt-pointed hard-rubber syringe of a capacity of three drams. Let the patient sit on a chair, his buttocks hanging over the edge; throw in a syringeful and let it at once run out; throw in another syringeful and hold it in from three to five minutes. In *acute gonorrhea* order two capsules three times a day, each capsule containing 5 grains of salol, 5 grains of oleoresin of cubebs, 10 grains of balsam of copaiba, and 1 grain of pepsin. After the patient micturates he should employ a mild astringent injection. If an astringent injection causes much pain, use a sedative injection—ʒij of boric acid, gr. viij of aqueous extract of opium, and ℥viij of liquor plumbi subacetatis dilutus. As the inflammation subsides increase the strength of the injection. A good plan is to order an eight-ounce bottle and eight half-grain powders of sulphate of zinc. Direct the patient to fill the bottle with water, in which one powder is dissolved; when this is used dissolve two powders in a bottleful of water, and so progressively increase the strength. When the discharge ceases stop the injections gradually. Whenever a syringeful is taken from the bottle a syringeful of water is put into the bottle, and thus pure water is soon obtained, at which point injection is discontinued.

Argonin, which is a combination of albumin, silver, and an alkali, is highly recommended by some authors as a local remedy for gonorrhea (Schäffer, Guthiel). A solution of this material is non-irritant, the silver is not precipitated by chlorids, and the agent destroys gonococci. It is used by injection or irrigation. If used by irrigation, employ a 1 : 500 solution twice a day. If used as an injection, employ a 1 : 200 solution six or eight times a day. When the discharge is found free from gonococci and remains free for three days, stop the argonin and use an astringent injection.

Protargol, metallic silver combined with a proteid, is a yellow powder soluble in water, the solution not being acted on by light. It is a non-irritant germicide. Neisser, after demonstrating the presence of the gonococcus, administers protargol by injection, the first injections being of a strength of 0.25 per cent., the strength being gradually increased to 0.5 per cent., and finally to 1 per cent. In the beginning he orders three injections a day, each injection being retained from fifteen to thirty minutes; after several days when the symptoms improve he gives only one or two injections a day, and these are continued for ten days after gonococci

disappear from the discharge. After protargol is abandoned an astringent injection should be used for a time. Some surgeons use a 1 : 1000, solution of protargol, and irrigate the anterior urethra and flush the bladder twice a day.

Methylene-blue internally is occasionally of service in gonorrhea. A capsule containing gr. ij of the drug is given three times a day. It makes the urine greenish-blue and occasionally induces strangury.

Ardor urinæ is relieved by urinating while the penis is immersed in hot water and by administering an alkaline diuretic. *Chordee* requires a bowel-movement in the evening, and sleeping in a cool room, under light covers, and on a hard mattress; bromid is given several times daily, and a considerable dose is given at night; it may be necessary to use suppositories of opium and camphor or to give hyoscin. *Balanitis* requires frequent washing with warm water, drying with cotton, and dusting with borated talc or with boric acid and subnitrate of bismuth (1 : 6). *Balanoposthitis* requires soaking in hot water, applications of lead-water and laudanum, and injections of black wash under the prepuce until edema of the foreskin subsides, and then cleanliness and the application of a drying powder. *Phimosis* requires soaking the penis in hot water, injections of hot water beneath the foreskin, followed by black wash, and the use of lead-water and laudanum externally. If this fails, circumcision must be performed. If *paraphimosis* occurs, grasp the head of the penis with the left hand, squeeze the blood out, and try to push the head back while with the right hand the penis is pulled upon, as if the surgeon intended to lift the individual by the organ. If this fails, cut the collar on the dorsum with scissors. *Bubo* requires the application of iodin, ichthyol, or blue ointment, the use of a spica bandage, and rest. If a bubo suppurates, it must be opened or aspirated. *Acute prostatitis* and *cystitis* require confinement to bed, a milk-diet, the use of alkaline diuretics, hot applications to the perineum and hypogastrium, suppositories of opium and belladonna or ichthyol, leeching the perineum, and the discontinuance of the balsams and injections. *Abscess of the prostate* requires instant incision. In *retention of urine* the patient should try to pass the urine while in a hot bath; if this fails, a soft catheter is used. After relieving the bladder put the patient to bed and apply hot sand-bags as for acute prostatitis. *Chronic prostatitis* requires cold hip-baths, cold-water enemata, deep urethral injections, plain diet, avoidance of alcohol and over-exertion, counter-irritation of the

perineum, and the relief of stricture or phimosis. Great benefit is occasionally derived from passing a soft bougie covered with blue ointment. If *epididymitis* arises, put the patient to bed, abandon injections, shave the hair from the groin, leech over the cord, elevate the testicles, and apply an ice-bag. Give a cathartic, a fever mixture, and suitable doses of bromid of potassium and morphin. The application twice a day of 20 drops of guaiacol in ℨj of cosmolin or olive oil gives great relief. When swelling lingers, after tenderness subsides strap the testicle with adhesive plaster. A lingering case is benefited by the internal use of iodid of potassium and the local application of ichthyol. In *gonorrheal ophthalmia* secure a watch-crystal over the unaffected eye, put the patient in a darkened room, rub the infected conjunctival sac with cotton soaked in a 2 per cent. solution of silver nitrate, wash out the affected eye often with hot boric-acid solution, keep the pupil dilated with atropin, leech the temple, give purgatives, and employ hot mustard foot-baths. Always send for an ophthalmologist.

Treatment of Chronic Urethral Discharges.—Gradually dilate the urethra with metal sounds. In chronic gonorrhea try to locate any existing granular or ulcerated patch with a bulbous bougie. When the point is discovered apply to it, by a deep urethral syringe, a few drops of a 2 per cent. solution of nitrate of silver. The strength of the silver solution can gradually be increased, or other solutions can be substituted (sulphate of copper or sulphocarbolate of zinc). Pass a large bougie every other day. Copious retro-irrigation with hot solutions of corrosive sublimate (1 : 20,000), permanganate of potassium (1 : 3000), or nitrate of silver (1 : 8000) does good. In many cases an electric endoscope is an indispensable instrument. By means of it the surgeon is enabled to locate the trouble and treat it locally. A common cause of chronicity is lingering inflammation of glandular structures and lacunæ. These spots should be touched through an endoscope tube, from time to time, with silver nitrate (3 per cent.). A granular patch should be treated in the same manner. In any lingering case of gonorrhea examine the urine, and direct suitable treatment for oxaluria, lithemia, or phosphaturia, if any one of these conditions exist. Such morbid states of the urine are occasionally responsible for great prolongation of the inflammation. In some cases a discharge is kept up by inflammation of the seminal vesicles (p. 1023). When may a man be considered well of gonococcus infection?

64

When shreds disappear from the urine; when an examination on three successive days fails to find gonococci; when the urine is free from pus, and when there has been no discharge for ten days.

Gonorrhea of the rectum occasionally, though very rarely, occurs. It may result from pederasty, or in a woman from a flow of infectious material from the genitalia to the anus.

Gonorrhea in the female may affect the vulva, the vagina, the urethra, or the uterus. The danger is the development of metritis or salpingitis.

The **treatment** for *vulvitis* is to place the patient upon a low diet and put her at rest with the pelvis elevated; every two or three hours spray the parts with peroxid of hydrogen, dry them with absorbent cotton, and dust them with equal parts of starch and oxid of zinc. In severe cases purge, use hot baths, apply lead-water and laudanum locally or paint the vulva with silver solution (gr. xl to ℥j), and leech the groins. If the vulvovaginal gland suppurates, open it.

For *vaginitis* follow the same general directions. Wash out the vagina every two hours, first with Oj of hot solution of bicarbonate of sodium, next with Oj of hot water, and finally with Oj of astringent solution (a teaspoonful of lead acetate, a teaspoonful of zinc sulphate, a teaspoonful of alum, or four teaspoonfuls of tannin to the pint of hot water) (White). As the attack subsides, use vaginal suppositories, each containing gr. v of tannic acid. In some cases apply solutions of silver nitrate, 1 : 200, and insert tampons moistened with boroglycerid and ichthyol, 8 per cent. (Le Blonde). Metritis must be prevented, and it is a wise precaution to apply iodin from time to time.

For *urethritis* use astringent injections locally and copaiba and cubebs by the mouth. In chronic cases use strong solutions of silver nitrate. The urethra and bladder may be irrigated with silver nitrate (1 : 8000).

For *uterine gonorrhea* observe the same general management. Swab out the uterus with tincture of iodin; use tampons of iodoform gauze and injections of peroxid of hydrogen.

Stricture of the urethra, or narrowing of the urethral caliber, is divided into *inflammatory*, *spasmodic*, and *organic*. The so-called *inflammatory* or congestive stricture is not a stricture, but is an inflammatory swelling of the mucous membrane.

Spasmodic stricture does not exist alone, but complicates

organic stricture, a hyperesthetic urethra, or an inflamed bladder.

Organic stricture is a fibrous narrowing of the urethra, due, as a rule, to chronic gonorrheal inflammation or to traumatism. Traumatic strictures occur in the bulbous or membranous urethra, and are due generally to force applied to the perineum, the urethra being squeezed between the subpubic ligament and the vulnerating body. Strictures resulting from gonorrheal inflammation occur in the penile, bulbous, or membranous urethra. Stricture never forms in the prostatic urethra except as a result of traumatism. Recent non-traumatic strictures are soft and are easily distended. Old strictures and traumatic strictures are very dense. A resilient stricture is one which contracts quickly after dilatation. The nearer a stricture is to the meatus, the more fibrous it is.

A *congenital* stricture is congenital narrowness of a portion of the urethra, usually the portion near the meatus. The more fibrous a stricture is, the more it narrows the urethra and the less dilatable it is. A stricture may be annular (forming a ring around the urethra), tubular (surrounding the urethra for a considerable distance), or bridle (when a band crosses the urethra from wall to wall). A stricture of large caliber will admit an instrument larger than a No. 15 French sound. A stricture of small caliber will not admit a No. 15 French sound. An impermeable stricture will not admit the passage of any instrument. Impermeable is more or less a relative term. A stricture may be impermeable when an anesthetic is not used, and permeable when the patient is anesthetized, or may be impermeable to one surgeon, but permeable to another. Impermeability is often a temporary condition due to inflammatory edema about an organic stricture.

Symptoms and Results of Stricture.—There is usually a history of repeated attacks of urethritis. A chronic discharge may exist, the amount of which is variable. There is a feeling of weight in the perineum, soreness of the back, and frequency of micturition. Hypochondriacal tendencies are usual. There is difficulty in starting the stream in micturition; the stream is small, twisted, often forked, and it dribbles long after the conclusion of the act, so that the penis must be "milked" before it is returned within the clothing. The urethra back of the stricture dilates, a pouch forms, drops of urine collect and decompose, and a chronic inflammation results in the mucous membrane or the parts

adjacent, which inflammation may go on to ulceration or to peri-urethral abscess. A urinary fistula results from the opening externally of a peri-urethral abscess. Retention of urine may occur, not from obliteration of the tube by the growth of the stricture, but closure of its lumen by edematous swelling in the neighborhood of the stricture, due to cold, wet, venereal excitement, the use of alcohol, over-exertion, etc. Spasm of the muscles results, and contact of the urine increases the spasm, and spasm plus edema of the mucous membrane closes the urethra. Spasm may exist in the urethra itself and in the muscles of the neck of the bladder, but is only a temporary condition. In old strictures the bladder is hypertrophied and often fasciculated, and is very liable to cystitis. The diagnosis of stricture and of its location is made by the use of exploratory bougies. In this examination the author follows to a great extent the plan of Ramon Guitéras, which is as follows:[1] have the patient pass urine into two glasses. Examine the urine for clap-shreds. Cloudiness in the first glass shows that urethral discharge exists. Cloudiness in the second glass points to cystitis. The patient is placed recumbent with his shoulders elevated, and the urethra is washed out with warm salt solution. Bulbous sounds are inserted, beginning with No. 15 French. If this passes with ease, take a larger size and note where strictures are situated by the catch on withdrawal. If No. 15 does not pass, use a smaller size. Remember that the posterior layer of the triangular ligament catches a bulbous instrument on withdrawal. If the meatus is too small to permit of exploration, divide it with a curved bistoury, cutting from within outward. After cutting the meatus bleeding is arrested with styptic cotton, and a piece of absorbent cotton is tucked into the cut. After each act of micturition the patient inserts a fresh bit of cotton, and after three days the urethral examination is proceeded with.

Treatment.—A stricture of large caliber in the deep urethra requires gradual dilatation. A steel bougie is introduced every fifth day, the size being gradually increased. Never anoint a bougie with cosmolin, as it may become a nucleus for a stone in the bladder; use oil or glycerin or lubrichondrin. Before passing an instrument the patient urinates and his urethra is washed out with boiled water or salt solution. The sound is rendered sterile by boiling before using. Gradual dilatation can be effected by the use of the dilator of Oberlander, the tube being distended

[1] *Med. Record*, Nov. 14, 1896.

to the extent of three millimeters every fifth day. If after dilatation there is urethral spasm, pain, or very frequent micturition, suspend the treatment for a number of days and order each night a hot hip-bath and a dose of paregoric. In effecting gradual dilatation by sounds the instrument should be introduced every fifth day, and during the treatment the patient should not use alcohol, should refrain from sexual excitement, should avoid cold and damp, and should take internally capsules containing boric acid and salol. It is rarely necessary to dilate above No. 32 French. After the surgeon finishes treatment he teaches the patient to use an instrument and directs him to pass it once a month. Strictures in the pendulous urethra, if soft, are treated by gradual dilatation; if fibrous and contractile, by internal urethrotomy. In performing internal urethrotomy prepare the patient carefully; for several days before the operation give salol and boric acid by the mouth, and wash out the bladder repeatedly with boric-acid solution. Be thoroughly aseptic. Anesthetize the patient. Before cutting irrigate the urethra with warm normal salt solution, and after cutting irrigate again and tie in a rubber catheter. These precautions will prevent urethral fever. In cutting, insert Gross's urethrotome (Fig. 397) back of the stricture, spring out the blade, cut the stricture on the roof of the urethra, close the blade, withdraw the instrument, and pass a full-sized bougie.

Stricture of the meatus requires incision with a knife and the use of a meatus bougie until healing is complete. Strictures of small caliber in front of the membranous urethra require gradual dilatation and, if this fails, internal urethrotomy or divulsion. Internal urethrotomy can be performed with the urethrotome of Maisonneuve (Fig. 395). This instrument is shaped like a sound, has a groove upon its surface, and into this groove a shaft carrying a triangular knife can be inserted. The staff is screwed to a guide, the guide is carried into the bladder and the staff follows it. The point of the staff is carried to the prostatic urethra and the guide curls up in the bladder. The penis is held upon the stretch, the blade is inserted and pushed down through the stricture. This instrument cuts the stricture, but not the healthy urethra. For divulsion the patient is prepared as for internal urethrotomy. The divulsor of Gross, or of Sir Henry Thompson, or of Gouley (Figs. 396, 398, 399) is introduced, the blades are separated, the instrument is withdrawn, a large bougie is passed, and a catheter is tied in the bladder. Strictures of small caliber in the deep ure-

thra require gradual dilatation; if this fails, employ external urethrotomy. In strictures of the deep urethra, if only a filiform bougie can be introduced, the bougie may be left in place,

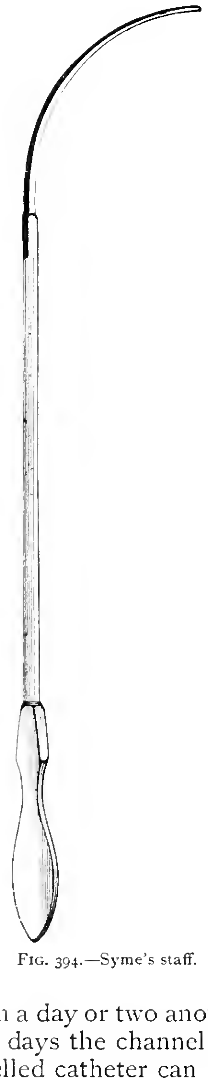


FIG. 394.—Syme's staff.

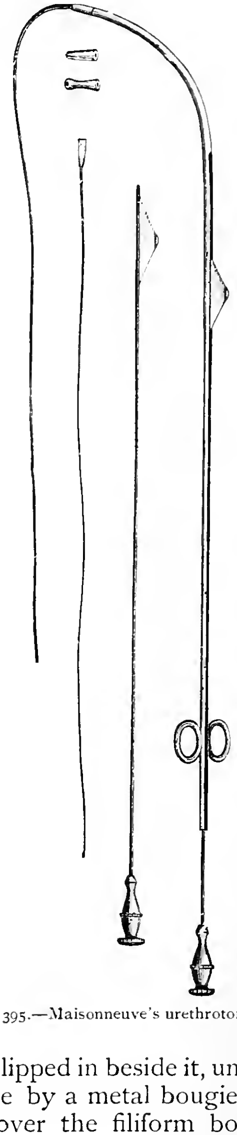


FIG. 395.—Maisonneuve's urethrotome.

and in a day or two another can be slipped in beside it, until in a few days the channel is permeable by a metal bougie. A tunnelled catheter can be slipped over the filiform bougie,

both be withdrawn, and a metal bougie passed. A tunnelled and grooved staff can be carried in over the bougie and external urethrotomy be performed. Thompson's dilator can be carried in over the filiform and the stricture be

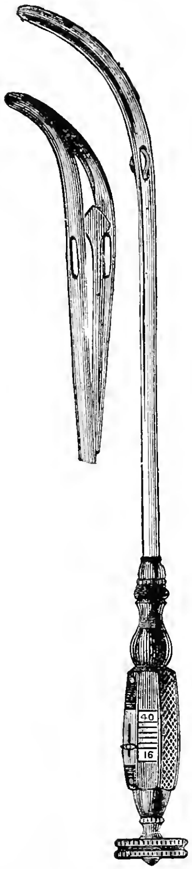


FIG. 396.—Gross's urethral dilator.

FIG. 397.—S. W. Gross's exploratory urethrotome.

divulsed. Fort's method of electrolysis is said to be of value, but I have had no personal experience with it. Fort treats stricture by linear electrolysis. His instrument looks like a whip, and it has a platinum blade projecting from about the center. The blade is connected with the negative

pole of a galvanic battery and the positive pole is placed over the pubes. The guide carrying the blade is inserted into the urethra, and when the blade comes against the stricture the current is turned on and the platinum passes rapidly through the constriction. The current is turned off and the instrument is carried onward until it strikes another stricture, when the current is again turned on, and so on. The necessary current-strength is 10 to 15 ma. The operation requires twenty to thirty seconds and causes but

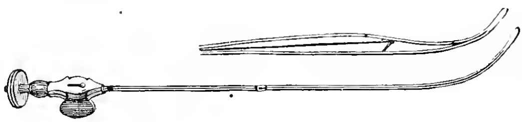


FIG. 398.—Thompson's divulsor.

little pain. After its performance a sound is passed (a No. 22 of the French scale). The patient need not be confined to bed after this operation. By Fort's method we act purely upon the diseased tissue. In impassable stricture of the deep urethra perform external perineal urethrotomy without a guide (the operation of Wheelhouse).

If a perineal fistula exists, dilate, divulse, or cut the stricture, retain a catheter in the bladder for forty-eight hours. After this period dilate every few days with a metal

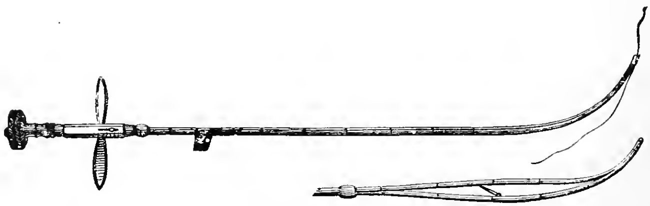


FIG. 399.—Gouley's divulsor.

instrument. Every morning and evening draw the urine with a soft catheter, introduce boric-acid solution into the bladder, remove the catheter, and let the man empty his bladder naturally. A portion will flow from the fistula and a part from the meatus. Day by day the quantity which comes from the fistula lessens, and finally the abnormal opening heals.

Urethral Fever.—Any operation upon the urethra may be followed by a chill owing to shock (urethral shock), and this may be followed by a nervous fever. Urethral fever

proper is a sapremia which may follow a urethral operation. This condition is due to absorption of toxic elements which may be in the urine, may have been in the urethra, or may have been introduced from without. It usually follows the first urinary act after operation. It begins with a violent chill and presents the characteristics of a septic fever. It is accompanied by a marked tendency to urinary suppression, and may eventuate in septicemia or pyemia. Urethral fever can be prevented by rigid antisepsis. If this fever should arise, a catheter must be tied in the bladder, the bladder and urethra must be repeatedly irrigated with aseptic or antiseptic fluids, and the patient must be given urinary antiseptics and stimulants by the mouth.

Urinary Fever.—Sir Benjamin Brodie pointed out that the withdrawal of residual urine in a case of enlarged prostate may be followed by very serious symptoms. The condition is spoken of as urinary fever, and is said by many to be due to the sudden and complete emptying of a bladder which has become accustomed to retaining permanently a considerable quantity of urine.

The condition does not arise promptly, suddenly, and violently, as does urethral fever, but begins rather insidiously after several days. Mr. C. Mansell Moullin thus describes the condition:[1]

"So far as the broader features are concerned, the symptoms that present themselves in these cases are remarkably uniform. They do not begin at once. Nearly always some few days elapse before there is anything to excite suspicion. Then the urine becomes cloudy, though it may still retain its acid reaction. A small quantity of albumin, more than can be accounted for by the amount of pus that is present, makes its appearance. Under the microscope there are a few hyaline casts, perhaps a blood-corpuscle or two, numerous pus-corpuscles, and myriads of bacteria. The specific gravity is lower than it ought to be, and is lower than it was before the catheter was used. The total amount passed in the twenty-four hours may either increase until it is as much as seven or eight pints, or diminish until it scarcely reaches twenty ounces. There is seldom any definite rigor, but there may be numerous slight chills. The pulse grows more rapid and feeble. The tongue becomes red and dry. There is complete anorexia. Delirium sets in at night, and in a considerable proportion of cases the symptoms rapidly grow worse

[1] *Lancet*, September 10, 1898.

and worse until, at the end of a few days, the patient sinks into a semi-comatose condition from which he seldom rallies. Post-mortem there are all the signs of recent acute cystitis and pyelonephritis. The mucous membrane lining the pelvis and calices of the kidneys, the ureters, and the bladder is swollen and stained by old and recent hemorrhages, and here and there a thin layer of pus is adherent to it. The pelvis and the ureters are dilated, the apices of the pyramids are eaten away, the cortex is shrunken and hard, the capsule is adherent, and in places between the tubules are minute collections of pus differing in shape and outline according to the anatomical arrangement."

Modern studies prove that urinary fever is due to infection of the bladder and kidneys, and not simply to the sudden withdrawal of all of the urine from the bladder, although such a procedure leads to vesical congestion and probably favors infection. The organisms most often found are pyogenic cocci, colon bacilli, and organisms which cause putrefaction and decomposition of urea.

Treatment.—Aseptic catheterization is necessary if we would avoid urinary fever; and as the urethra contains some of the causative organisms, the prepuce, glans, and meatus should be washed with soap and water and irrigated with boric-acid or permanganate of potassium solution, and the urethra be irrigated with boric-acid solution or permanganate of potassium before the sterile catheter is introduced to draw the urine.

If urinary fever arises, it may be possible to control it by frequently irrigating the bladder with warm normal salt solution, solution of nitrate of silver (1 : 8000), or boric-acid solution, and by administering stimulants, diuretics, diaphoretics, saline cathartics, and nutritious food. In severe cases perform suprapubic cystotomy for drainage.

Perineal section is external perineal urethrotomy. There are three methods, the operation of Syme, of Wheelhouse, and of Cock.

Syme's Operation.—This operation is employed if a stricture is very contractile, if dilatation fails to cure, or if urethral instrumentation causes fever. The patient is anesthetized, Syme's staff (Fig. 394) is introduced, and the surgeon makes an incision in the midline of the perineum and exposes the staff just above the shoulder of the instrument. The knife is carried along the groove and divides the stricture. A catheter is passed into the bladder from the meatus and is retained for several days, and the wound is dressed

antiseptically. After the catheter is removed it must be used every six hours until the urine comes entirely by the meatus. From time to time, for the rest of the patient's life, a full-sized sound should be passed.

Wheelhouse's Operation.—This operation is employed for the treatment of impermeable stricture. Wheelhouse's staff is passed into the urethra until it blocks on the stricture. The perineum is incised down to the staff and in front of the stricture. The edges of the cut urethra are held apart with forceps, the surgeon seeks for the opening through the stricture, passes a fine probe through it, divides the stricture, carries into the bladder from the wound an instrument known as a gorget to dilate the canal and furnish a solid floor to facilitate the introduction of a catheter. With the gorget in place a metal catheter is carried from the meatus into the bladder. The gorget is removed and the catheter is tied in place. After three or four days the catheter is removed and is then passed frequently. The perineal wound is, of course, dressed antiseptically.

Cock's Operation.—This operation opens the urethra back of the stricture and without a guide relieves retention of urine. The surgeon introduces into the rectum the index-finger of the left hand, and the tip of the finger is rested upon the apex of the prostate gland. The surgeon incises the median line of the perineum, the back of the knife being toward the anus. When the point of the knife is felt to be near the finger the handle is lowered slightly, the blade is placed a little oblique, and the urethra is opened. A catheter is passed into the bladder from the wound and retained for a time, and the stricture is subsequently treated.

Epispadias is a congenital cleft in the corpora cavernosa, the roof of the urethra being completely or partly absent. In complete epispadias there are absence of the pubic arch and exstrophy of the bladder.

Partial epispadias may sometimes be remedied by a plastic operation.

Hypospadias is a congenital cleft on the floor of the urethra, the meatus opening on the floor at some point between the scrotum and the end of the glans penis, the channel in front of the meatus being a gutter and not a tube.

Hypospadias of the glans is the most common form. In this condition the urethra has no floor, as it passes beneath the glans, the site of the urethra is indicated by a groove, and the foreskin is absent below. Partial hypospadias requires no treatment except possibly dilatation or incision of the meatus.

People who suffer from it are very prone to develop chronic urethral inflammation. In hypospadias of the penis the ill-developed cord-like corpus spongiosum draws the penis to the scrotum. In this variety of the deformity the penis is very short.

In complete hypospadias the opening of the urethra is back of the scrotum in the perineum, the penis is dwarfed and bound down, and looks not unlike a clitoris, the scrotum is divided into two portions, a gap existing between them, and in many cases the testicles have not descended. Such individuals are occasionally mistaken for females. In the penile complete forms of hypospadias a plastic operation should be performed between the eighth and tenth year of age. Such an operation unfortunately may fail. Hypospadias is rare in women, but it may occur. In such a case the urethra opens into the vagina.

Chancroid (soft chancre; the local venereal sore) is a pyogenic ulcer, usually of venereal origin. The name chancroid was introduced by Clerc, who believed that a soft sore resulted from inoculating a person already syphilitic with the products of a hard sore. He further held that when a soft sore arose the syphilitic poison lost its infective properties, and "could be transmitted as a soft sore to a healthy person, and not cause general infection."[1] This form of ulcer is not connected with the syphilitic poison and is not due to any special or chancroidal poison, but is produced by inflammatory products or irritating secretions. In fact, soft sores may arise without a causative sexual intercourse, as is seen sometimes in cases of herpes in a man with gonorrhea, the herpetic ulcers becoming chancroids. As a rule, chancroids are of venereal origin, and result from contact with other chancroids, pus, mucopus, or areas of ulceration. There is no special germ. A chancroid appears soon after intercourse, usually within five days, always within ten days. It is first manifested by a pustule which ruptures and discloses an ulcer. This ulcer has sharply-defined and undermined margins; it looks "punched out;" the base is gray and sloughy; the discharge is profuse, purulent, foul, and auto-inoculable, and causes fresh chancroids by flowing over the parts. The area around a chancroid is red and inflamed, and considerable pain is apt to be complained of. The original chancroid spreads and new sores appear. The edge of a chancroid is rarely indurated unless caustics have been used or there is mixed infection with syphilis. Inflammatory in-

[1] *Syphilis*, by Alfred Cooper.

duration fades gradually into the tissues, but the induration of a hard chancre is sharply defined. Fournier says that a chancroid may have a hard base if the sore is located in the sulcus back of the glans, on a lip of the meatus, or on the lower border of the prepuce of a man with phimosis, or when the ulcer is inflamed. Fournier maintains that the surgeon should always ask if the sore has been cauterized and how it has been treated. When a chancroid after a time displays marked and sharply-outlined induration it points to mixed infection of chancroid and syphilis. Chancroids are not followed by constitutional symptoms, but are apt to be accompanied by painful inflammatory buboes which are prone to suppurate. In hospital practice about 30 per cent. of patients develop buboes. The bubo may be one-sided or bilateral. If pus forms, it does not contain organisms. The adenitis of chancroid is due purely to the absorption of toxins. Cases have been reported in which non-indurated sores were followed by syphilis. It is probable that a mixed infection existed, and that induration was overlooked, because a papular initial lesion was underneath the chancroidal ulcer. When inflammation in chancroids is high a rapidly destructive ulceration known as *phagedena* may arise, but this process is more common in syphilitic sores.

Treatment.—Ordinary cases of chancroid are treated by spraying with peroxid of hydrogen, drying with cotton, touching each sore first with pure carbolic acid and then with pure nitric acid, and dressing with black wash or dusting with iodoform or with calomel. Every few hours the patient soaks the penis in hot salt water (a teaspoonful of salt to half a pint of water), sprays the sores with peroxid of hydrogen, dries with cotton, and dresses with black wash or dusts with iodoform or with calomel. As soon as granulation begins the sores should be dressed with 1 part of ointment of nitrate of mercury to 7 parts of cosmolin. Mild cases do well without cauterizing, peroxid of hydrogen being frequently used and a drying powder being employed. In chancroids with phimosis slit up the foreskin, burn the edges of the wound with pure carbolic acid, and treat the ulcers by cauterization. A regular circumcision often fails because of infection of the stitch-holes. Phagedena requires the internal use of iron, quinin, and milk-punch, and the local use of powerful caustics (bromin or nitric acid or even the actual cautery). In some cases continuous antiseptic irrigation is valuable. When a bubo first begins order rest, apply iodin or an ointment of belladonna or ichthyol, and

make pressure by a spica bandage of the groin. Some surgeons advise the injection of 20–40 minims of a solution of carbolic acid (gr. x to the ounce), but we have never seen any benefit from it. Some inject a 1 per cent. solution of bichlorid of mercury, but the proceeding causes intense pain. Welander recommends the injection of a 1 per cent. solution of benzoate of mercury. We have had no experience with this method. If the bubo persists, even though it does not suppurate, it should be completely excised. If pus forms, several methods of treatment are open to us. Aspiration, injection with a solution of carbolic acid, squeezing out the acid and injecting 10 per cent. ointment of iodoform and glycerin, and sealing the opening with collodion (Scott Helms). Hayden makes a puncture, squeezes out the pus, washes out the cavity with peroxid of hydrogen and then with corrosive-sublimate solution, injects warm iodoform ointment, and dresses with cold, moist, corrosive-sublimate gauze to set the ointment. Otis, Fontain, Perry, and others commend this plan. We have often found it to succeed. If the above-mentioned plan fails, if it is not used, or if an ulcer or sinus exists, incise, curet, cauterize with pure carbolic acid, cut away hopelessly infiltrated skin, and pack the wound with iodoform gauze. In some cases it will be necessary to extirpate fragments of gland.

Phimosis is a condition of the prepuce that renders retraction over the glans impossible. It is usually congenital, but it may arise from inflammation. Congenital phimosis causes retention of sebaceous matter, which decomposes and lights up inflammation. The prepuce is apt to grow fast to the glans. Congenital phimosis may induce irritability of the bladder, incontinence of urine, prolapse of the rectum, and various nervous symptoms. The treatment is *circumcision.* Asepticize the parts. Grasp the foreskin and the mucous membrane with two forceps, draw the prepuce forward, catch the skin (at the point it is desired to cut) horizontally between the arms of the handle of a pair of scissors, and cut off the redundant prepuce. Retrench the excess of mucous membrane by cutting around with scissors one-quarter of an inch from the glans, stitch the skin to the mucous membrane with catgut, and dress with sterile gauze (Fig. 400).

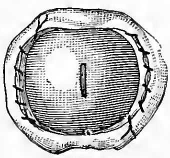


Fig. 400.—Circumcision completed (Esmarch and Kowalzig).

Fracture of the penis, which is a laceration of the cavernous bodies with extravasation of blood, occurs occa-

sionally during coition. The **treatment** consists of cold and bandaging to arrest bleeding, and occasionally incisions to let out clot.

Gangrene of the penis arises from phagedena, from tying constricting bands around the organ, from fracture with excessive hemorrhage, and from paraphimosis. If extensive, it requires amputation.

Cancer of the penis is commonest in persons with phimosis. In a limited epithelioma of the foreskin circumcision is performed and the glands of the groin are removed; if cancer affects the glans, amputation is required, and the glands are removed.

Amputation of the Penis.—Ricord advised cutting off the organ with a single stroke of the knife, making four slits in the mucous membrane of the urethra, and stitching each of these flaps to the skin. Treves splits the skin of the scrotum along the raphé, separates the halves of the scrotum down to the corpus spongiosum, passes a metal catheter down to the triangular ligament, inserts a knife between the corpus spongiosum and the corpora cavernosa, withdraws the catheter, cuts the urethra across, detaches the urethra from the penis back to the triangular ligament, cuts around the root of the penis, divides the suspensory ligament, detaches each crus from the pubes, slits up the corpus spongiosum half an inch, stitches its edges to the rear end of the scrotal incision, introduces a drainage-tube, ligates the vessels, and sutures the wound.

Seminal Vesiculitis.—Inflammation of the seminal vesicles is due to the extension of a gonorrheal inflammation or a pyogenic process.

Acute inflammation is made evident by frequent and painful micturition, pains in the anus, rectum, and perineum, and possibly the hip-joint, back, and thigh. Defecation and micturition are excessively painful. Persistent erections may take place, and in some cases bloody ejaculations occur. Rectal examination detects the enlarged and tender vesicles external to the lateral lobes of the prostate and on a higher level.

Treatment.—Abandon local urethral treatment, and treat the patient as for acute prostatitis.

Chronic vesiculitis may result from the acute form or may come on insidiously in an individual with gonorrhea. It is one of the causes of chronic urethral discharge. The patient suffers from imperative and frequent demands to micturate, and he has a gleety discharge which becomes worse and

better, but does not disappear. This chronic inflammation is believed to persist because of narrowing of the duct, and consequent incomplete drainage of the vesicle. In chronic seminal vesiculitis there is usually sexual weakness, nocturnal emissions occur, and the semen may contain blood.

Treatment.—Treat the posterior urethritis by ordinary methods. Use hot rectal enemata. Milk the ducts by Fuller's method once every seven days. The patient's bladder should be full. He leans over a chair-back, the knees being straight and the body at a right angle to the thighs. The surgeon introduces his finger into the rectum and makes pressure over the pubes with the fist of the other hand. The finger comes in contact with the lower half of the vesicle; it makes firm pressure for a moment, and is then drawn slowly toward the duct. This stroking is repeated several times. The other vesicle is treated in the same manner. This maneuver empties the vesicle and hastens the resolution of inflammation. After the completion of the stripping the patient should micturate, and the bladder and urethra should be irrigated.

Prostatitis (see p. 1008).

Prostatorrhea.—Just as overaction of the glands of the urethra constitutes urethrorrhea, so overaction of the glandular apparatus of the prostate gland constitutes prostatorrhea. Prostatorrhea is not inflammatory, although the prostate and posterior urethra are often congested, and the latter region is usually hyperesthetic. In some cases urethrorrhea exists with prostatorrhea. Prostatorrhea is produced by sexual excess, masturbation, ungratified sexual desire, and riding a bicycle with an improper seat. The condition is usually accompanied by marked neurasthenia, and may be associated with spermatorrhea and impotence.

The patient notices a gray discharge after straining at stool (defecation-spermatorrhea), after violent exercise, sexual excitement, or a bicycle-ride. Examination of the discharge shows it to be prostatic fluid, although spermatozoids are sometimes found. The bladder is irritable, and there are frequency of micturition and often some pain in the head of the penis at the termination of the act. Nocturnal emissions may occur.

Treatment.—Stop bad habits. If there is urethral hyperesthesia or prostatic congestion, irrigate the bladder and urethra once a day with a solution of silver nitrate (1 : 4000), and every fourth or fifth day introduce a cold sound. In some cases the occasional instillation into the prostatic

urethra of a few drops of a 1 per cent. solution of nitrate of silver does good.

For the irritable bladder give hot hip-baths at night. The following prescription is of service: gr. xv of bromide of potassium, $\frac{1}{2}$ dram of tincture of hyoscyamus in $\frac{1}{2}$ ounce of cinnamon-water, three times a day. Hot enemata are of service.

After the hyperesthesia of the urethra has abated, and nocturnal emissions have ceased, the neurasthenia is treated by cold sponging of the body night and morning, the continued use at intervals of several days of a large-sized cold sound, irrigation every second or third day with silver nitrate (1 : 4000), and the administration of strychnin and other tonics.

Hypertrophy of the prostate gland is a senile change occurring only after the age of fifty, and being most apt to occur after the age of sixty. All the lobes may be enlarged equally, all may be enlarged but unequally, or only one lobe may be enlarged. Prostatic hypertrophy causes narrowing and lengthening of the urethra, and gives this tube a tortuous course. The opening of the urethra into the bladder is pushed to a higher level, and there forms behind it a pouch in which urine collects. This urine, which is known as *residual urine*, may collect in large quantity; it cannot be voluntarily expelled, and it is apt to decompose, producing cystitis. The bladder enlarges, thickens, and becomes fasciculated, micturition becoming very difficult and sometimes impossible. An enlarged middle lobe will block the flow, and the bladder inevitably becomes greatly distended. In hypertrophy of the prostate the ureters, the renal pelves, and calyces may distend, and surgical kidney may develop.

Symptoms.—In 80 per cent. of all cases there is only slight inconvenience. The stream of urine is slow to start and falls feebly from the end of the penis. The last drops fall entirely without control, and there are occasional episodes of nocturnal frequency of micturition. In 20 per cent. of all cases the bladder cannot be emptied entirely, and residual urine collects in the bladder. Frequency of micturition comes on, particularly at night; the patient has to get up often; the bladder never feels empty; and cystitis is apt to arise. The urine, at first acid and clear, becomes neutral and cloudy, and finally ammoniacal and turbid, and contains bacteria, mucopus, precipitates of phosphates, and blood. Above the pubes there is aching pain, soon spreading to the perineum, which pain is increased when the bladder is dis-

tended and during micturition. Enlargement of the lateral lobes can be detected by a finger in the rectum. The rectum becomes irritable, and piles form or prolapse of the mucous membrane occurs. Attacks of retention of urine may occur. The bladder becomes thin and distended, or hypertrophied, rigid, and fasciculated. In rare cases true incontinence is caused by the median lobe growing toward the neck of the bladder and preventing closure. The health breaks down because of pain, restless nights, indigestion, and disorder of the bowels. The kidneys may become involved (inflammation of the pelves or calyces, or surgical kidney), and suppression may occur. Septic fever may arise. Calculi may form in the bladder. Death is due to exhaustion, suppression of urine, or septic cystitis. A foul catheter is the usual cause of septic cystitis, but micro-organisms sometimes enter by passing along the urethral mucous membrane.

Treatment.—Many cases can be treated by regular catheterization. Alexander has formulated several sound rules as to when catheterization is the proper treatment. He says, if the patient is intelligent and dexterous, if cystitis is not severe, if the amount of residual urine is not very large, if obstruction is not great, if the bladder retains considerable expulsive power, and if catheterization is easy and painless, rely upon this simple plan of treatment. Prevent cystitis by emptying the bladder each evening with a coudé catheter. If there is trouble in passing the catheter, strengthen the instrument by inserting a filiform bougie as a stylet (Brinton). In some cases a metal instrument with a large curve is used. Teach the patient to use the instrument himself. A dirty instrument may cause fatal infection. It is true that some people use dirty instruments for long periods without trouble, but in most cases there will be trouble if it is attempted. It is absolutely necessary to use only perfectly aseptic instruments. Metal instruments are sterilized by boiling in water. Rubber catheters can be cleansed by washing with soap and running water and boiling, or, after washing, soaking in corrosive-sublimate solution. Woven instruments can be placed in a glass cylinder, the bottom of which is like a sieve. This jar is placed for twenty-four hours in a vessel which contains formalin. The vapor of formalin is an excellent germicide, and does not injure the catheter. After sterilization the instruments are kept ready for use in a glass cylinder which contains calcium chlorid.[1]

[1] R. W. Frank, in *Berliner klin. Woch.*, No. 44, 1895.

Guyon scrubs the catheters with soap and water, dries them outside and inside, places them in a sealed jar, and exposes them to the vapor of sulphurous acid for forty-eight hours. If there are three ounces of residual urine, use the catheter only at night. If there are six ounces, use it night and morning. If there are more than six ounces of residual urine, add one more catheterization a day for every additional two ounces present until the catheter is used six times in the twenty-four hours. It should never be used oftener than this. Gradual dilatation with steel sounds is of benefit, but forcible dilatation is not advisable. Tell the patient to avoid violent exercise, cold, damp, sexual excitement, and the use of alcoholic liquors, prevent constipation and indigestion, and direct him to drink milk and plenty of water. A hot hip-bath at night adds to his comfort. Hot enemata are of value. If a large quantity of residual urine exists, or if cystitis begins, wash out the bladder daily with boric-acid solution, or normal salt solution, or nitrate of silver (1 : 12,000), and give urotropin or salol and boric acid by the mouth (Cystitis, p. 976). In some severe cases, if a large-sized rubber catheter be tied in the bladder for a few days, great relief is obtained. Retention of urine can be relieved by the introduction of a coudé catheter strengthened with a whalebone, of a silver instrument with a prostatic curve, or by aspiration. Most cases can be kept comfortable by catheterization, and only when this fails should an operation be performed. If the symptoms grow constantly worse, if the suffering becomes severe, if the patient cannot urinate without the use of an instrument, if catheterization is painful or impossible, if the patient is too careless or ignorant to trust with a catheter, if only a catheter of very small size can be introduced, if attacks of obstinate retention occur, if there is persistent cystitis or hematuria, if the residual urine gradually increases in amount, the bladder should be opened.

The perineal operation is as safe, or safer, than the suprapubic, and can be rapidly performed. In this operation the drainage is at the lowest part of the bladder, and by an incision of the prostate gland the floor of the urethra may be lowered to the level of the floor of the bladder (Dandridge). A large tube should be worn during the healing of the wound.

The suprapubic operation is easier than the perineal, it is no safer, it gives excellent results if temporary drainage only is needed. If siphon drainage is not used, the opening is better placed in the perineal operation, unless permanent

drainage is required. After the suprapubic operation the floor of the urethra cannot be brought level with the floor of the bladder by a simple incision of the prostate, it can only be brought level by the performance of prostatectomy. After a suprapubic cystotomy has been performed for drainage, the opening may be kept permanently patent by the retention of a tube (Hunter McGuire's operation). Fig. 391 shows Senn's tube.

Suprapubic prostatectomy may be performed. After the bladder is opened the mass of prostate is enucleated or cut away with scissors or with cutting-forceps. The bladder is drained for a time and the suprapubic cut is then allowed to heal. McGill's operation is suprapubic prostatectomy, the gland being removed partly by enucleation and partly by the employment of cutting rongeur-forceps. If the suprapubic method of prostatectomy is employed, it is wise to use also a perineal cut, in order to control hemorrhage and secure good drainage (Dandridge). Fuller performs a suprapubic cystotomy, makes a small incision through the mucous membrane of the gland, enucleates the gland with the finger, and drains through an incision in the membranous urethra. Belfield makes a suprapubic and a perineal cut, and with the finger in the perineum pushes the gland into easy reach of the finger in the bladder.

Perineal prostatectomy may be employed. Some surgeons make a curved incision across the perineum and dissect out the gland. Nicoll first performs suprapubic cystotomy, opens the perineum down to the prostate, splits the capsule of the prostate, inserts two fingers of the left hand into the bladder, and pushes the prostate down into the perineum. The surgeon enucleates the gland through the perineal wound without damaging the mucous membrane of the bladder. Alexander makes the suprapubic cut and uses it for the same purpose as Nicoll, but he opens the membranous urethra on a grooved staff, enucleates the gland, and inserts a drainage-tube through the perineal wound. Bottini of Padua, by means of a special instrument, cauterizes the prostate. This instrument is shaped like a catheter, and carries a platinum blade which is heated by an electric current.

Bottini's galvanocaustic operation is performed as follows: The bladder should be emptied, irrigated, and distended with air and the posterior urethra must be anesthetized by instillation of cocain or eucain. The current is tried to see how many seconds it requires to heat the blade sufficiently. The current is broken, the instrument is introduced, the cooling

current is set in motion, and one assistant watches this and nothing else. Turn on the current. Wait the required number of seconds for the blade to become red hot (twelve to fifteen seconds), turn the screw at the handle, and burn a groove in the prostate. A groove should be burned toward the rectum, one to the side, and, if it is thought desirable, one to the opposite side. No groove should be burned toward the pubes. When a groove has been burned, return the blade into its sheath, increasing the current while doing so in order to keep the blade from adhering to the tissue, then shut off the current. After withdrawing the instrument it is not necessary to introduce and retain a catheter. The patient is confined to bed only twenty-four hours, there is rarely bleeding or fever, and the results are good. It is alleged that fibrous stricture of the neck of the bladder may follow in some cases.[1]

In 1893 J. William White introduced the operation of bilateral orchidectomy. He proved that removal of the testicles causes a rapid shrinking in an enlarged prostate. Part of this shrinking may be due to diminution of congestion and edema, but true atrophy undoubtedly occurs. Very remarkable results have been recorded. In most cases the patient becomes absolutely comfortable. Some cases dispense entirely with the catheter. Cystitis ceases, and desire to urinate frequently becomes less marked. Unilateral orchidectomy has been employed, but it is not satisfactory. Bilateral division or exsection of the vas deferens, vasectomy, may be employed instead of orchidectomy. This operation was suggested by Mears. It is slower in its results, but just as certain. In spite of the great simplicity of orchidectomy the mortality has been considerable (from 11 to 18 per cent.). In several instances mental disturbance has followed the operation, but there is no real evidence that it was due to this special form of operation and would not with certainty have followed any other.

Among other operations which have been suggested are ligation of the cord; ligation of the vascular elements of the cord; resection of all the cord elements except the vas and its artery and vein (angioneurectomy); parenchymatous injections of cocain into the testicles, the patient taking tablets of prostate extract internally; and ligation of both internal iliac arteries.

[1] For description of this operation, see Freudenberg, in *Berlin. klin. Woch.*, No. 46, 1897; and Willy Meyer, in *Med. Record* of March 5, 1898, and May 12, 1900.

The relative merits of these various operations alluded to above are in dispute. It is certain that very many cases of prostatic hypertrophy can be kept comfortable by aseptic catheterism. If this procedure fails or for other reasons must be abandoned, a careful study of the case should be made before selecting a special operation. The Bottini operation is coming into extensive use. Some would apply it to almost any sort of case, and claim that the operation is practically free from danger. Meyer uses it for any case of uncomplicated hypertrophy; but if the prostate is very large ligates the vasa deferentia some weeks before cauterizing the prostate, in order to lessen the danger of thrombosis.

A more conservative view is that of Eugene Fuller, who doubts the permanence of the results of the Bottini operation, fears that stenosis of the vesical neck may follow, and would restrict the operation to uncomplicated cases, not of a grave character and in which the bladder has not been seriously damaged.

Of 164 reported cases, 80 were cured, 44 were improved, 29 were not improved, and 14 were fatal (Meyer). The real status of the operation has not yet been definitely determined.

Orchidectomy or vasectomy may produce great benefit or may fail completely. These operations are most serviceable in cases in which the entire prostate is enlarged and soft, and are not adapted to fibrous or myomatous prostates nor to conditions of valve-like obstruction at the vesical neck. If such an operation is done early in a case, the mortality is small (3 to 5 per cent.); if performed later, it is considerable or even large (10 to 20 per cent.).

Prostatectomy is an operation which is followed by many deaths (10 to 20 per cent.). The earlier the operation is performed the safer it is.

In old men with great obstruction, and with serious disease of the bladder and involvement of the kidneys, permanent suprapubic drainage is usually the most useful procedure.

Retained and Malplaced Testicle.—The testicle may be arrested in its passage to the scrotum: it may remain in the lumbar region; it may reach the internal abdominal ring; it may lodge in the inguinal canal; it may emerge from the external ring, but fail to enter the scrotum; or it may pass into unnatural positions, as into the perineum or the crural canal. It may or may not be functionally active. A retained testicle is subject to attacks of orchitis and may become sarcomatous. In 80 per cent. of cases the testicles

have descended at birth; most often it is the right testicle which fails to descend. Sometimes a testicle descends after being retained for months or even years. In Keyes' case it descended in the thirtieth year. Late descent usually causes hernia.

Treatment.—If one testicle is undescended one year after birth, and the other testicle is sound, the former should be removed if it is found impossible to draw the gland into the scrotum and fasten it. Always try to get a retained gland into the scrotum, and operate before the age of puberty.

Orchitis is inflammation of the testicle. *Acute* orchitis may be due to cold, wet, traumatism or epididymitis, gout, mumps, rheumatism, or a specific fever. The testicle is round, swollen, tender, and very painful, the scrotum is red and swollen, the tunica vaginalis is filled with fluid, and there is fever. *Chronic* orchitis results from the acute form or from a chronic urethral inflammation, and is almost always combined with epididymitis. Chronic orchitis may be due to syphilis.

The **treatment** of the *acute* form consists of rest in bed and applications as for epididymitis (page 1032). The *chronic* form requires the removal of the causative lesion, the wearing of a suspensory bandage, applications of ichthyol or mercurial ointment, and the administration of iodid of potassium by the mouth. Strapping may do good. Castration may be required.

Tuberculosis of the testicle may be primary, but in most instances is secondary to tuberculosis of the prostate, bladder, or seminal vesicles. The disease may be preceded by pulmonary tuberculosis, peritoneal tuberculosis, or tubercular disease of bones or joints; and primary tuberculosis of the testicle may be followed by distant tubercular lesions. In some cases involvement of the prostate exists, but cannot be detected (latent tuberculosis of the prostate); in other cases the prostate is in a state of subacute inflammation. The disease begins in one testicle, but in the vast majority of cases the other testicle becomes involved after a few weeks or months. It usually comes on gradually; but it may begin acutely as I have seen in two instances during the progress of tubercular peritonitis. The disease is apt to arise after a slight injury or inflammation, and is most common in young men, but may arise at any age. Nodules form most commonly in the epididymis, but sometimes in the testicles as well. These nodules soften and run together, and the cord is felt to be enlarged. After a time the skin becomes

red and adherent, gives way, and exposes a caseous breaking-down epididymis or testicle. Except in the acute cases, the testicle is only slightly, if at all, painful, and tenderness is trivial. A small hydrocele often forms.

Treatment.—Castration would appear useless if the prostate is involved or if other organs are tubercular, although Koenig maintains that after castration nodules in the prostate may disappear. The best operation in most instances is the removal of as much of the testicle or epididymis as seems to be diseased. We thus remove a dangerous area of infection. Before operating in most cases try the effect of climate, good hygiene, nourishing diet, the local application of guaiacol, pressure, and heat.

Orchidectomy or Castration (Excision of a Testicle).—In this operation an incision is made over the cord, commencing just outside the external ring and running down over the base of the tumor. Clamp the cord and divide near to the ring, remove the testicle, ligate the spermatic artery alone, and then ligate the entire thickness of the cord. The cord is ligated with chromic gut. The skin is sutured with silkworm-gut. Drainage is not required. It is often advisable to remove a considerable amount of scrotal skin.

Epididymitis, or inflammation of the epididymis, is usually due to inflammation of the urethra. It is apt to occur in the stage of decline of a gonorrhea, and is announced by a complete cessation of the discharge. It may result from the passage of a urethral instrument, the voiding of urine which contains fragments of calculi, or as a complication of prostatic hypertrophy. *Acute* epididymitis is characterized by swelling about the testicle, pain in the groin, and tenderness over the posterior part of the testicle. The pain becomes acute, swelling rapidly increases, and the constitution sympathizes. The swelling is due partly to engorgement of the epididymis and partly to fluid in the tunica vaginalis (acute hydrocele). *Chronic* epididymitis is usually linked with orchitis, and it follows an acute attack or a chronic urethral inflammation.

Treatment by aseptic puncture with a tenotome, if fluctuation is marked, will relieve tension and pain. Leeching over the external abdominal ring, use of an ice-bag, elevation, application of guaiacol, and administration of laxatives and opium are used in the acute stage. Application of guaiacol over the cord, epididymis, and testicle quickly relieves pain and distinctly lessens swelling. Three applications a day should be made for one week. At each applica-

tion paint upon the scrotum 2 c.c. of equal parts of glycerin and guaiacol (I. Clifford Perry), and paint the scrotum and over the external ring twice a day with 15 drops of guaiacol in 1 dram of glycerin or olive oil. Strapping is employed as the inflammation subsides. The treatment of the chronic form is the same as that for chronic orchitis.

Hydrocele (chronic hydrocele) is a collection of fluid in the tunica vaginalis testis. An enlargement of the testis may cause it, but in most instances the cause is unknown and no signs of inflammation exist. The fluid is albuminous, but it does not coagulate spontaneously; it is thin, straw-colored, and may contain crystals of cholesterin. The testicle is at

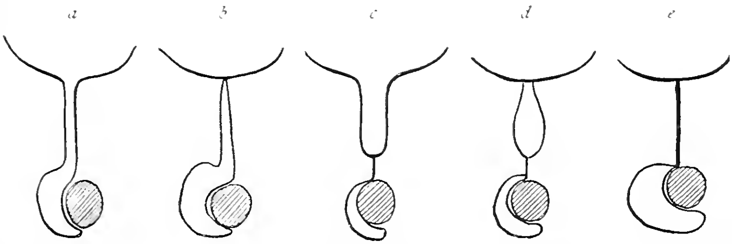


FIG. 401.—Varieties of hydrocele: *a*, congenital; *b*, infantile; *c*, funicular; *d*, encysted; *e*, vaginal.

the lower and back part of the sac. The pyriform mass fluctuates, is translucent, grows from below upward, and the introduction of an exploring-needle permits the yellow fluid to flow out.

Treatment.—Simply tapping the sac with a trocar is only palliative; air must run in as fluid runs out, and suppuration may occur, which will be dangerous without drainage. Never tap a rigid sac. The injection of irritants should be abandoned, as it exposes the patient to serious danger because of inflammation occurring without provision for drainage. Hearn incises the sac, dries its interior with bits of gauze, swabs it out with pure carbolic acid, packs it with iodoform gauze, and dresses it antiseptically. The packing is removed in twenty-four hours and the wound is allowed to close. If the sac is rigid and will not collapse, either stitch it to the skin and pack it or excise a large portion of its parietal layer and insert a drainage-tube (Volkmann's operation). It has recently been proposed to tap the sac with a trocar and cannula, to leave the cannula in place as a drain for some days, and to dress antiseptically.

Congenital hydrocele is hydrocele through an unclosed

funicular process into the tunica vaginalis. If the pelvis is raised, the fluid runs back into the peritoneal cavity, from which it originally came. The **treatment** is the application of a truss to obliterate the funicular process.

Infantile hydrocele is a collection of fluid in a funicular process and the tunica vaginalis, the funicular process being closed above, but not below. The **treatment** is to puncture the sac and to scarify the sac-wall with a needle.

Encysted Hydrocele of the Cord.—In this variety the funicular process is obliterated above and below, but it is patent between these two points, and fluid collects. The **treatment** is the same as that for infantile hydrocele. If this fails, incise and pack.

Funicular Hydrocele.—The funicular process is closed below, but is open above. Raising the pelvis causes the fluid to trickle back into the peritoneal cavity. The **treatment** is the application of a truss.

Encysted hydroceles of the testicles and of the epididymis may occur. *Diffused hydrocele* of the cord is simply edema of the cord. *Hydrocele of a hernia* is the distention of a hernial sac with peritoneal fluid.

Hematocele.—*Vaginal hematocele* is blood in the tunica vaginalis, the result of traumatism, a tumor, or the tapping of a hydrocele. There is a pyriform tumor, which fluctuates, but which gradually becomes firmer; the scrotum is livid, and the testicle is below and posterior to the tumor. The *encysted* form of *hematocele of the cord* is a hydrocele of the cord into which bleeding has occurred. The *diffused* form is due to extravasation of blood into the cellular substance of the cord. *Encysted hematocele of the testicle* is due to effusion of blood into an encysted hydrocele of the testicle. *Parenchymatous hematocele* is extravasation of blood into the substance of the testicle.

The **treatment** of a recent case of vaginal hematocele is to put the patient to bed, support the scrotum, and apply an ice-bag over the testicle. If the swelling does not soon abate, incise, irrigate, and pack.

Varicocele is varicose enlargement of the veins of the pampiniform plexus. An irregular swelling exists in the scrotum and extends up the cord. This swelling feels like "a bag of earth-worms;" it exhibits a slight impulse on coughing; the scrotal skin and cremaster muscle are attenuated; the testicle lies at the bottom of the swelling and is softer and smaller than normal; the swelling diminishes on lying down and increases on standing or on making pressure

over the external ring. There is usually some discomfort, aching, or dragging in the testicle or the groin, and even neuralgic pain in the cord. There is sometimes mental depression and hypochondria.

Treatment.—In treating varicocele, reassure the patient: tell him there is no real danger of impotence; order cold shower-baths, correct constipation and indigestion, give occasional tonics, and order the patient to wear a suspensory bandage. If the testicle becomes much atrophied, if the pain and the dragging are annoying, or if the mind is much depressed, operate.

XXXVII. AMPUTATIONS.

An amputation is the cutting off of a limb or a portion of a limb. Removal of a limb or a portion of a limb at a joint is known as "disarticulation." Amputation may be necessary because of the existence of severe injury, of gangrene, of tumors, of intractable disease of bones or joints, of ulcers which will not heal, of traumatic aneurysm, etc. A re-amputation may be required because of the existence of a defect or disease in the stump.

Classification.—Amputations are classified as follows: (1) As to time of operation after the injury: a *primary* amputation is performed soon after the occurrence of the accident—as soon as the sufferer reacts from shock, and before he develops fever; a *secondary* amputation is performed some time after the accident, suppuration having supervened (Stokes); and an *intermediate* amputation is performed during the existence of fever, but before the development of suppuration. (2) As to the situation, where the bone is divided or according to which joint is cut through. (3) As to the form and situation of the flap.

In performing an amputation maintain rigid asepsis; completely remove the hopelessly-damaged portion; sacrifice as little of the sound tissue as possible; prevent hemorrhage during the amputation, and carefully arrest it after the operation; have enough sound tissue in the flap to *cover* the bone, and enough skin to cover the muscles; and secure drainage at a dependent point.

Hemorrhage is prevented by the elastic bandage of Esmarch (Fig. 402). In an ordinary case apply this bandage from the periphery to well above the line of the prospective incision, encircle the limb with the elastic band (not a thin tube), and remove the bandage. The bandage and band, which are asep-

ticized before using, are applied to the limb, which has been carefully sterilized. After the band has been applied the limb should not freely or forcibly be moved, because of the danger of tearing muscles which are firmly set by the compressing band. When elastic compression is used in an operation the surgeon should be very careful to tie *every visible vessel*.

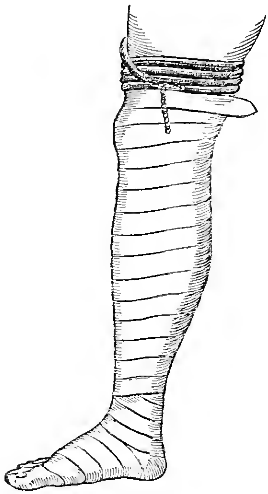


FIG. 402.—Esmarch's elastic bandage.

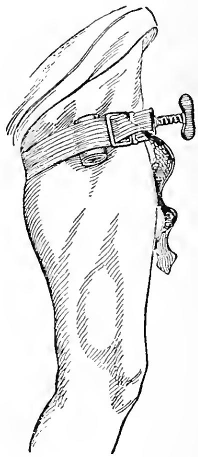


FIG. 403.—Application of tourniquet.

The paralysis of the small vessels induced by pressure often prevents bleeding, and unless their mouths be found and the vessels be tied reactionary hemorrhage will occur. Reactionary hemorrhage is the great danger after the use of the Esmarch bandage, and paralysis or sloughing may also follow its employment. If there be an area of suppuration or of gangrene or an extra-osseous malignant growth, do not apply the bandage as directed above. One bandage can be applied from the periphery to near the lower border of the area of growth or infection, and another, from near the upper border of this area, up the limb. The contents of the area (tumor-cells and fluid or septic products) are not squeezed into the circulation. In cases like the above many surgeons hold the extremity in a vertical position for five minutes, lightly stroking it toward the body with the hand, and at once apply the constricting band. As a matter of fact, this plan satisfactorily empties the limb of blood, and it is not necessary in any case to force the blood out by elastic compression. Some surgeons prefer the tourniquet.

Figs. 404 and 405 show two forms of tourniquet. To apply Petit's tourniquet, place the plates in contact, apply

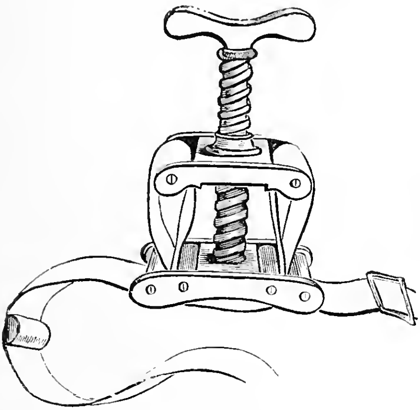


Fig. 404.—Petit's spiral tourniquet.

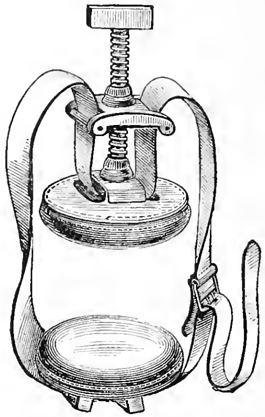


Fig. 405.—Charrière's tourniquet.

a small firm compress over the artery and a broad thick compress over the outer surface of the limb, buckle the tapes around the limb so that the plate is over the broad pad, and tighten the tourniquet by separating the plates with the screw (Fig. 403). When a tourniquet is applied to

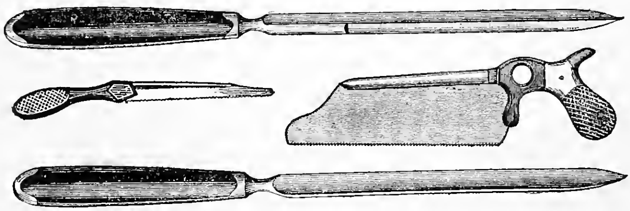


Fig. 406.—Catlin, knife, and saws for amputations.

arrest bleeding during transportation, bandage the limb, sew the compress pad to a bandage, and place the plates of the instrument over the pad. Signorini's horseshoe tourniquet may be used upon the brachial artery. In hip-joint and shoulder-joint amputations Wyeth's pins are passed, and after the limb is emptied of blood the band is fastened above them. These pins prevent the bands from slipping.

The instruments and appliances required are Esmarch's apparatus or tourniquet, amputating-knives, a bone-knife,

scalpels, saws, a lion-jawed forceps, bone-cutting forceps, a periosteum-elevator, retractors of linen, dissecting-, hemostatic, and toothed forceps, a tenaculum, an aneurysm-needle, a probe, scissors, needles, ligatures, sutures of silkworm-gut, dressings, bandages, and solutions. A retractor has two tails for the thigh and arm and three tails for the leg and forearm: it is made by taking a piece of muslin eight inches wide and twelve inches long and cutting tails on one side eight inches in length.

Methods of Amputating.—Circular Method (Fig. 407).—The surgeon should stand to the right of the limb and use a long amputating-knife which cuts from heel to point. After an assistant has retracted the skin the operator divides the soft parts by a series of circular cuts. Do not cut at once to the bone, but divide the skin and subcutaneous tissues. At the retracted edge of the first cut divide the superficial muscles, and after these muscles retract divide the deep muscles. Incise the periosteum with a bone-knife, push up the periosteum with an elevator, and after the application of the retractors saw the bone, starting the saw from heel to point. A periosteal flap can be made to cover the end of the bone, but it is unnecessary. In this amputation is formed a

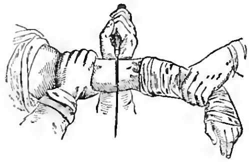


FIG. 407.—Amputation of arm by the circular method (Druitt).

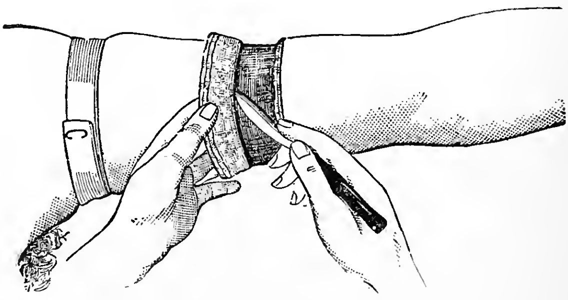


FIG. 408.—Circular amputation: dissecting up the skin-flap (Esmarch).

cone whose apex is the bone and whose base is the skin-edge. In one form of circular amputation (*amputation à la manchette*) the retracted skin is cut by a circular sweep of the knife, a cuff of skin and subcutaneous tissue is freed and turned up, and the muscles are cut circularly at the edge of the turned-up cut (Fig. 408). The pure circular

amputation is performed on the arm and the thigh; the amputation *à la manchette* is performed chiefly through the wrist and the lower forearm.

Modified Circular Method.—In this operation the circular skin-cut may be modified by making a vertical incision to join the first wound, the muscles being cut by a circular sweep or by making two vertical skin-incisions. Liston's modification consists in dissecting up two short semilunar integumentary flaps and in dividing the muscles circularly. This is known as the "mixed method" (Fig. 409). The

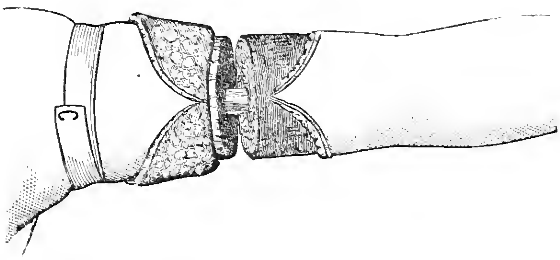


FIG. 409.—Modified circular amputation: skin-flaps and circular through muscles (Esmarch).

modified circular can be used upon the thigh, the leg, the arm, and the forearm.

Elliptical Method.—This method stands midway between the circular operation and the operation by a single flap. An elliptical incision is made through the skin and subcutaneous tissues, the tissues are pushed up or turned back, and the muscles are divided circularly or cut partly by transfixion. This method is employed particularly in certain disarticulations.

Oval or Racket Method.—In an *oval* amputation the incision through the skin and subcutaneous tissue is an oval with a pointed end or a triangle, and the other parts down to the bone are cut from without inward. When a longitudinal incision down to the bone (Fig. 415, *a*, *b*) extends from the point of the oval (*a*, *b*) the operation is called the "racket" amputation. If the longitudinal cut joins a circular cut, the operation is known as a "T" amputation. The oval or racket operation is performed at the metacarpophalangeal, metatarsophalangeal, and shoulder-joints; the T operation may be performed at the hip-joint.

Flap Method.—A flap may be composed of *skin* only or of both *skin* and *muscle*, but the skin-flap must always be

longer than the muscle-flap, so that the latter will be covered by it. A flap containing much muscle heals badly, but the best flap has a moderate amount of muscle (enough skin to cover the muscle and enough muscle to cover the bone). Flaps may be *single* or *double*. Double flaps may be *lateral* or *antero-posterior*, *square* or U-*shaped*, *equal* or *unequal*, and they may be cut by *transfixion* (Fig. 410), by cutting from without inward, by dissection, or by cutting the skin from without inward and the muscles by transfixion. When an amputation is completed, tie the main vessels, pull down the nerves and cut them high up, smooth the flaps, take off the constricting band, and after arresting hemorrhage apply sutures. In some cases the deep parts are stitched with a continuous catgut suture and the superficial parts are closed with silkworm-gut; in other cases the deep parts are not stitched at all, the skin alone being sutured with silkworm-gut. Drainage-tubes should be used except in amputations of the fingers and toes.

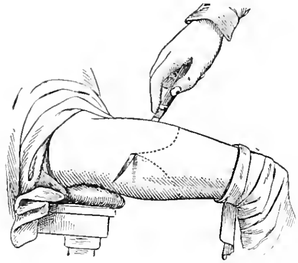


FIG. 410.—Amputation of the thigh by transfixion (Gross).

SPECIAL AMPUTATIONS.

Fingers and Hand.—In amputating the thumb and index finger save every possible scrap of tissue. In either of the fingers, if it be necessary to amputate above the middle of the middle phalanx, the attachment of the flexor tendons will be cut off and the finger will be liable to project directly backward, so that it is better with these fingers either to disarticulate at the metacarpal joints or to stitch the flexor tendons to the periosteum. The flexor tendons have fibrous sheaths extending from the proximal end of the distal phalanx to the metacarpophalangeal articulations, these sheaths being thin and collapsible opposite the joints, but being thick and rigid opposite the shafts of the bone. The fibrous sheath is known as the *theca*, and when it is cut in an amputation it should be closed, otherwise it may carry infection to the palm of the hand. The theca does not exist over the distal phalanx, and it is not distinctly visible over the joint between the distal and middle phalanges. To effect closure over the shaft of a bone, strip up the periosteum and pass catgut sutures vertically

through the theca and the periosteum (Treves). In amputation of the fingers and the thumb an Esmarch bandage is unnecessary, though pressure may be made upon the arteries at the wrist. Only two or three ligatures are necessary. Close with a very few sutures, so as to favor drainage between the threads.

The distal phalanx is best removed by a long palmar flap (Fig. 411, A). The palmar flap (A) is marked out by cutting through the skin and subcutaneous tissue. The incisions are next carried to the bone, the flap is dissected from the bone, the finger is strongly flexed, a transverse incision (B) is carried across the dorsum on a level with the base of the third phalanx, the soft parts are pushed back, the joint is opened, the lateral ligaments are cut from within outward, the third phalanx is forcibly extended, and the remaining structures are cut from below upward. The middle phalanx can be removed by the same method (C). The proximal phalanx can be removed by a long palmar flap or by a long palmar and a short dorsal flap (D, E).

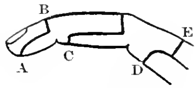


FIG. 411.—Amputation of the finger.

Disarticulation of a metacarpophalangeal joint is best performed by the oval or racket method. The incision upon the dorsum (A) is begun just above the head of the metacarpal bone, is carried down to beyond the base of the phalanx, and involves the skin only (Fig. 412). One incision sweeps around the finger at the level of the web, going only through the skin (B); the finger is extended and the palmar cut is carried to the bone; each lateral incision is carried to the bone while the finger is bent in the opposite direction, the flaps are dissected back to the joint, the finger is strongly extended, the joint is opened from the palmar side, and disarticulation is effected. Cutting off the head of the metacarpal bone improves the appearance of the stump but weakens the hand, hence in a workingman it must not be done unnecessarily. If it is necessary to remove a metacarpal bone, the incision (C) is made from the carpometacarpal joint.

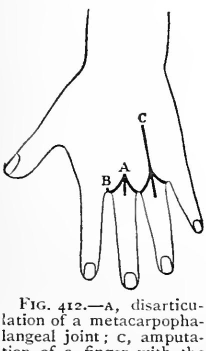


FIG. 412.—A, disarticulation of a metacarpophalangeal joint; C, amputation of a finger with the metacarpal bone.

Amputation of the thumb through its distal or proximal phalanx is performed identically as is an amputation of a finger. Amputation of the thumb, with a portion or the whole of its

metacarpal bone, is performed by the oval or racket incision.

Amputation of the wrist-joint can be done by the circular method or by a double flap. In the double-flap amputation a dorsal flap is made by carrying a semilunar skin-incision between the styloid processes; the skin is lifted, the wrist is forcibly flexed, the joint is opened by a transverse cut, and a long semilunar palmar flap which includes only the skin and fascia is made by dissection.

Amputation through the forearm may be effected by the circular method (Fig. 408), the modified circular, or the flap operation. An excellent plan is to make a semilunar dorsal skin-flap and a semilunar skin-flap on the flexor surface. The flaps are raised, the muscles are cut circularly (Fig. 413), the interosseous space is cleared with the knife, a three-tailed retractor is applied, the periosteum is pushed up, and the bones are sawn half an inch above the flap. In sawing the bones, start the saw upon the radius, draw it from heel to point, make a furrow on the radius and ulna, and saw both bones at same time. After sawing, cut away any irregular edge with bone-pliers. In the lower third Teale's amputation may be done, the dorsal flap being the long one. In Teale's amputation rectangular flaps are made. The long flap is equal in width and length to one-half the circumference of the limb at the point where it is to be sawn. The short flap is equal in width to the long flap, but is only one-fourth its length. The two longitudinal cuts are at first taken only through the skin, but the two transverse cuts go at once to the bone. The flaps are dissected up from the interosseous membrane and the bone. In the middle or the upper third of a fleshy arm two semilunar skin-flaps can be cut from without inward, and the muscle can be cut by transfixion.

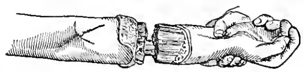


FIG. 413.—Modified circular amputation of the forearm (Bryant).

Disarticulation of the elbow-joint can be done by the elliptical method or by a long anterior and short posterior flap. In the latter operation the forearm is partly flexed and a skin-cut marks out a long anterior flap, the knife being entered opposite the external condyle and being withdrawn one inch below the internal condyle. The muscles, which are bunched forward, are cut by transfixion. A posterior semilunar flap is made, which separates the attachments of the radius, the ulna is cleared, and the triceps is cut at its insertion (Bell). Gross advocated sawing through the olecranon and the inner trochlear surface.

Amputation of the arm is best performed by marking out with a knife two equal semilunar anteroposterior flaps, the first cut being carried through the skin alone, the muscles being then transfixed with a long knife. Teale's method is shown in Fig. 204. The circular or the modified circular amputation may be performed.

Disarticulation at the Shoulder-joint.—In this operation Wyeth's pins are passed to hold the Esmarch band

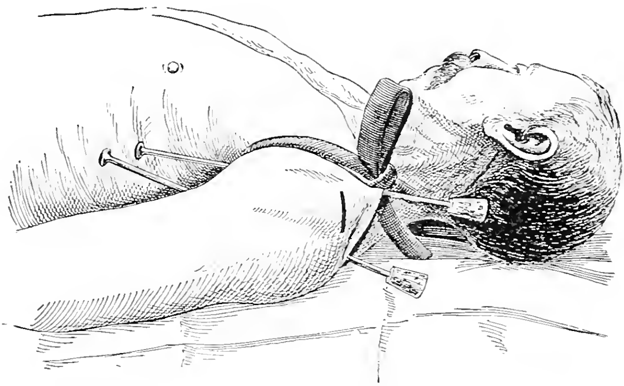


FIG. 414.—Use of Wyeth's pins in amputation at the shoulder-joint. The acromion is marked by a black line (Keen).

in place. The anterior pin is entered at the middle of the lower margin of the anterior axillary fold, and emerges one inch within the tip of the acromion. The posterior pin is entered at a corresponding point on the posterior axillary fold, and emerges more posteriorly than the first pin and an inch within the tip of the acromion. The Esmarch band is applied above the pins (Fig. 414).

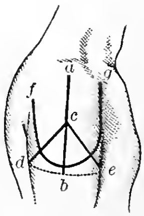


FIG. 415.—Amputation at the shoulder-joint: *a,b,c,d,e*, Larrey's operation; *f, g*, Dupuytren's operation.

Larrey's Operation.—In this method of shoulder-joint disarticulation the limb is held from the side and an incision is made down to the bone, the incision beginning just below and in front of the acromion and running vertically for four inches down the outer surface of the arm (Fig. 415, *a b*). From the center of this incision an oval incision (*c d*, *c e*) is carried around the arm, the inner aspect of the oval reaching as low as the lower end of the vertical cut. The oval incision at first involves only the skin and subcutaneous tissues. The anterior structures are divided close to the bone, and the

posterior structures are next cut. To disarticulate, cut the capsule transversely upon the head of the bone; while the arm is rotated outward cut the subscapularis, and while the arm is rotated inward cut the supraspinatus and infraspinatus and the teres minor. Cut away any tissue holding the humerus to the body; cut away hanging nerves, capsule-fragments, and tissue-shreds, and sew up the wound vertically. Bell advises an oval incision with a racket handle. Spence used an anterior racket incision.

Dupuytren's Method.—In Dupuytren's shoulder-joint disarticulation a U-shaped flap is marked out by a skin-incision (Fig. 415, *f g*). If the amputation is to be at the right shoulder, the arm is carried across the chest; the knife is entered at the root of the acromion, follows the margin of the deltoid, and is withdrawn at the coracoid process, the arm being gradually abducted and pulled off from the chest. If the left shoulder is to be amputated, the procedure is reversed (Treves). The knife now cuts through the deltoid and raises a flap composed of this muscle, the shoulder-joint is exposed, and disarticulation is effected as in Larrey's method. The knife is passed down back of the bone and a short internal flap is cut. Lisfranc's amputation is by transfixion with the formation of an anterior and a posterior flap, and can be performed very rapidly, but only a most skilful surgeon should attempt it.

Amputation of the Entire Upper Extremity.—Berger's Amputation.—This operation is an amputation above the shoulder-joint. By it are removed the arm, the scapula, and a portion of or the entire clavicle. It is occasionally employed in cases of malignant disease and of severe injury. The operation is attended with profuse hemorrhage, and as a preliminary the subclavian vessels should be ligated. The incisions must be varied according to the necessities of the case. In this operation Berger divides the clavicle at the junction of its outer and middle thirds, and resects the middle third of the bone; ligates and divides the subclavian vessels; cuts the anterior flap (Fig. 416); divides the brachial plexus; marks out the posterior flap; and completes the operation by dividing the structures which hold the shoulder-

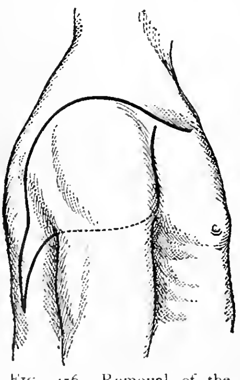


FIG. 416.—Removal of the whole upper extremity.

blade to the chest. It is in this last step that bleeding is profuse.

Amputation of the Toes and the Foot.—Only in the great toe is *partial* amputation performed, and it is effected by the formation of a long plantar flap, just as a long palmar flap is formed from the finger. Amputation at the metatarsophalangeal joints is performed by an oval or racket incision (Fig. 417, *c*). Amputation of a toe with removal of its metatarsal bone is shown in Fig. 417, *a b* and *d e*.

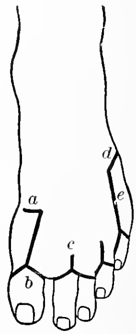


Fig. 417.—Amputation of the toes with and without the metatarsal bones.

Amputation at the Tarsometatarsal Articulation.—Lisfranc's Method (after Treves).—In order to amputate the right foot by this method begin an incision on the outer border of the foot, behind the tubercle of the fifth metatarsal bone; carry the incision forward one inch and sweep it across the foot half an inch below the tarsometatarsal articulations; bring the incision to the inner edge of the foot, half an inch in front of the tarsal articulation of the big toe, and carry the cut straight along the inner margin of the foot until it reaches a point three-fourths of an inch above the articulation of the metatarsal bone of the great toe. A very short semilunar dorsal skin-flap is thus formed. After the skin-flap is dissected back for a quarter of an inch the tendons are divided, and the flap, which now contains all the soft parts, is dissected back to *above* the joint. A long plantar flap is cut, reaching from the origin of the first flap to the necks of the metatarsal bones. The skin-flap is dissected up until the hollow behind the heads of the metatarsal bones is reached, when, with the toes in extension, the tendons are cut across and a flap composed of all the soft parts is dissected up to above the tarsometatarsal joint.

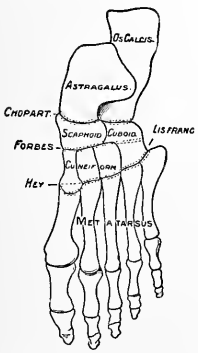


Fig. 418.—Lines in amputations of the foot (Gross).

Fig. 418 shows the line of Lisfranc at the tarsometatarsal articulation. The joint is opened from the outer side according to the following rule: in separating the fifth metatarsal direct the edge of the knife toward the distal end of the first metatarsal; in separating the fourth metatarsal

direct the knife toward the middle of the first metatarsal; in separating the third metatarsal carry the knife almost directly across. The separation is facilitated by bending down the front of the foot, and at the same time the tendons of the peroneus brevis and tertius are divided. Open the joint between the first metatarsal and the inner cuneiform bone, turning the knife toward the middle of the shaft of the fifth metatarsal, and at the same time

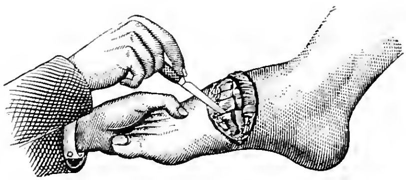


FIG. 419.—Lisfranc's amputation: first step (Guérin).

divide the tibialis anticus muscle. Treves says that in disarticulation of the second metatarsal the knife is to be held as a trocar, it is to be thrust between the base of the first and second metatarsal bones until the point strikes bone (Fig. 419), and is then to be raised to a perpendicular and the cut is to be made toward the external malleolus to sever the ligament of Lisfranc (Fig. 420). Divide any remaining ligaments, and also the tendon of the peroneus longus muscle. The skin-incisions in the *left* foot are begun

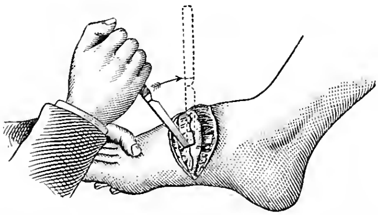


FIG. 420.—Lisfranc's amputation: second step (Guérin).

on the inner side, and in disarticulating the tarsal joint of the great toe is first opened. Fig. 421 shows the parts after disarticulation at the line of Lisfranc.

Hey's Method.—In Hey's method the incision is practically the same as that for Lisfranc's amputation. The four external metacarpal bones are disarticulated, but the first metatarsal is removed by sawing a portion of the internal cuneiform bone. Guérin advised sawing all the bones across.

Skey advised the division of the head of the second metatarsal. Fig. 418 shows the line of Hey.

Amputation through the Middle Tarsal Joint.—Chopart's Amputation.—Make a transverse incision through the skin of the instep, two inches below the ankle-joint; cut the tendons and muscles, expose the tarsus, and make on each side a small longitudinal incision reaching to below and in front of the corresponding malleolus. The flap thus formed is retracted. The plantar flap is made as in Lisfranc's amputation. Open the astragalo-scaphoid joint, then the calcaneocuboid joint, and disarticulate. Fig. 418 shows the line of Chopart. Fig. 422 shows the parts after Chopart's disarticulation. In *amputation through the tarsus* Forbes of Toledo advises making flaps

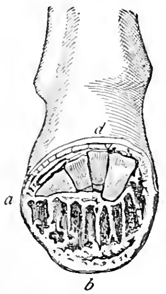


FIG. 421.—The parts after Lisfranc's amputation (Bernard and Huette).

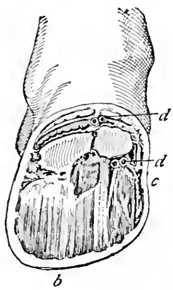


FIG. 422.—The parts after amputation by Chopart's method (Bernard and Huette).

as in Chopart's amputation, disarticulating the scaphoid from the cuneiform bones, and sawing through the cuboid. Fig. 418 shows the line of Forbes.

Amputation at the Ankle-joint.—Syme's Method.—The foot is held at a right angle to the leg, and a skin-incision is carried, from just below the external malleolus, straight across or a little backward across the sole to a corresponding point on the opposite side. Do not take this incision near to the inner malleolus, as to do so will endanger the posterior tibial artery. The incision is carried to the bone, the flap being pushed back and separated from the bone by means of a strong knife and the thumb-nail until the tuberosity of the os calcis has been reached. The foot is now extended and a transverse cut is made across the dorsum, joining the two ends of the first incision; the ankle-joint is opened, the lateral ligaments are cut, disarticulation is effected, and the foot is finally completely removed by

severing the tendo Achillis. A thin piece of bone including both malleoli is sawn from the tibia and fibula. The flap is perforated posteriorly to secure drainage.

Pirogoff's Method.—Flex the foot to a right angle with the leg. "Make an incision from the tip of the internal malleolus across the sole, a little in front of the long axis of the tibia, to a point in front of the apex of the external malleolus down upon the bone."[1] Dissect the flap backward from the calcaneum for a quarter of an inch, but do not dissect the flap from the posterior portion of the os calcis. Join the extremities of the first incision by another cut which reaches to the bone, and which is "half an inch in front of the lower extremity of the tibia" (Bryant); but saw off this bony projection obliquely and leave it adherent

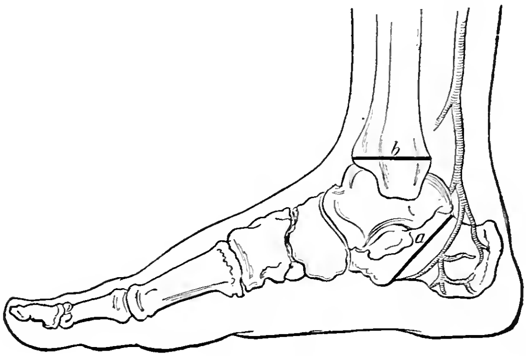


Fig. 423.—Lines of section of the os calcis and the bones of the leg in Pirogoff's amputation.

to the tissues. The saw is used after disarticulation of the ankle-joint; it is passed behind the astragalus, cutting downward and forward, sawing the os calcis obliquely, and leaving a considerable portion in place in the flap. The lower ends of the tibia and fibula are well exposed by raising the anterior flap slightly; the sawing is begun anteriorly just above the articular surface, and is completed half an inch above the articular surface posteriorly. The lines *a* and *b* (Fig. 423) show the sections made by the saw. The sawn surface of the os calcis is brought into contact with the sawn surfaces of the tibia and fibula, and the flaps are sutured.

Amputations of the Leg.—The so-called "point of election" is at the upper part of the middle third of the leg.

[1] *Operative Surgery*, by Joseph D. Bryant.

Seventy years ago Liston advised surgeons not to amputate in the lower third of the leg because of the scantiness of the soft parts, because the stump is apt to ulcerate, and because it is uncomfortable in an artificial leg. These views have been much modified. The amputation near the ankle is safer than the amputation near the knee, and artificial legs are now made which may be worn with comfort. In amputations of the leg by the *long anterior flap*, cut through the skin, dissect up the anterior muscles with the flap, and cut all the posterior tissues with a single transverse sweep. Amputation by the *rectangular flap*, Teale's method, is very useful (see page 1042). The long flap is anterior, and is in length and breadth equal to one-half the circumference of the limb. The short flap is one-fourth the length of the long flap. The flaps are dissected up, the bones are sawn, the long flap is turned upon itself, and its edges are sutured to the edges of the short flap.

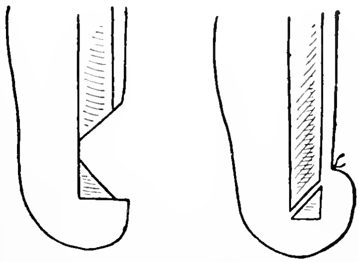


Fig. 424.—Diagrammatic representation of amputation of the leg after the method of Bier.

Bier suggests a plan (Fig. 424) to increase the supporting power of the stump after a leg-amputation. After the wound has healed, a wedge-shaped piece of bone is removed above the level of the stump. The lower extremity is turned forward and upward through an arc of 90 degrees, and unites in this position (Zuckerkandl's *Operative Surgery*). Thus the medullary cavity is closed and the skin which must bear pressure is healthy and free from cicatrices; and as the muscles are still attached to the bone, they do not undergo atrophy.

Sédillot's leg-amputation (Fig. 425) is by a long external flap. A longitudinal incision is made along the inner edge of the tibia, the tissues are drawn toward the fibula, a knife is introduced and passed to the outer edge of the tibia, just touching the fibula, and is brought out posteriorly,

thus transfixing the calf-muscles and cutting an external flap. A convex incision is made on the inner side, the bones are cleared and are sawn one inch above the flaps, half an inch more being taken from the fibula than from the tibia, and the tibia being bevelled anteriorly.

Modified Circular Amputation of the Leg.—Cut semilunar skin-flaps, lay them back, and cut circularly to the bone at the edge of the turned-up flap. Another method of modified circular amputation is by adding to the circular cut a vertical incision down the front of the leg. In sawing the bones of the leg the surgeon, who stands to the outer side of the right leg or to the inner side of the left leg, divides the fibula first, and at a higher level than the tibia, and bevels the anterior surface of the tibia. In sawing the left fibula the saw points to the floor; in sawing the right fibula it points to the ceiling.

Fig. 425.—Sédillot's amputation of the leg (Wyeth).

Amputation of the Leg by a Long Posterior and a Short Anterior Flap.—In this operation a posterior U-shaped flap is made equal in length and breadth to the diameter of the limb. The skin-incision is begun one inch below the point where the bone is to be sawn, and behind the inner edge of the tibia, and is carried to a point posterior to the peronei muscles. The gastrocnemius muscle is divided transversely at the level of the flap, the soft parts on either side in the line of the flap being cut to the bone. Through these vertical cuts the muscles are lifted from the bones and are divided through their lower part by cutting from within outward. The anterior flap is formed by making a semilunar skin-flap and by cutting the muscles across at its retracted edge (Fig. 426). *Amputation of the leg by lateral flaps* is not a popular operation, as it offers too much encouragement to subsequent protrusion of the bone.

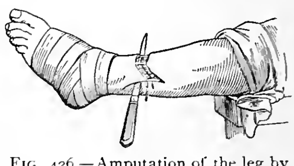


Fig. 426.—Amputation of the leg by a long posterior flap (Gross).

Bier endeavors to broaden the support after amputation of the leg by performing a cuneiform osteotomy and bending the lower fragment to a right angle with the upper, and obtaining union of the fragments (Fig. 424).

Amputation just below the Knee.—The seat of election is one inch below the tuberosities. No muscle is needed in the flap. Cut two flaps of skin, equal in size and semilunar in shape, these flaps beginning anteriorly two inches below the tuberosity of the tibia. One flap is antero-external and the other is postero-internal. The flaps are pulled up, the anterior muscles are cut as high up as possible, and the posterior muscles are cut through the middle of the portion exposed (Bell). The bone is sawn one inch below the tuberosity.

Disarticulation of the Knee.—In disarticulation by the long anterior flap, make a long anterior skin-flap, incise the ligament of the patella, turn up the flap with the patella, open the joint, and complete the disarticulation by cutting from within outward and downward. The knee may be disarticulated by means of a long anterior and a short posterior flap.

Amputation through the Femoral Condyles.—*Syme's Method by a Long Posterior Flap.*—Carry a skin-incision, with

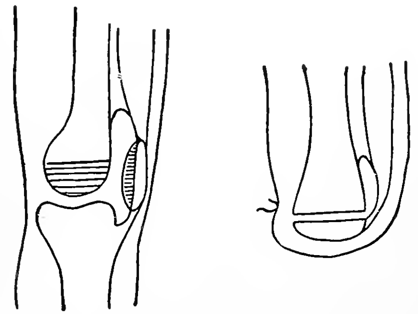


FIG. 427.—Diagrammatic representation of Gritti's operation.

a very slight downward curve from one condyle to the other, across the middle of the patella. Cut down to the bone, retract the flap, and cut the quadriceps above the patella. Insert a long knife at one angle of the wound, pass it back of the femur, and make it emerge at the opposite angle, cutting a posterior flap eight inches long. Retract the posterior flap, clear for sawing, and section the condyles horizontally. Carden made a curved section of the condyles at their widest part. In children Buchanan showed that we can easily separate the lower femoral epiphysis. In Gritti's supracondyloid amputation an oblique incision is made. The upper end of the incision is posterior and just above the condyles. Its

lower end is anterior and two finger-breadths below the patella (Kocher). The ligament of the patella is cut, the flap is turned up, the femur is sawn at the base of the condyles, the articular face of the patella is sawn off, and the sawn patella is fastened to the sawn femur and the flaps

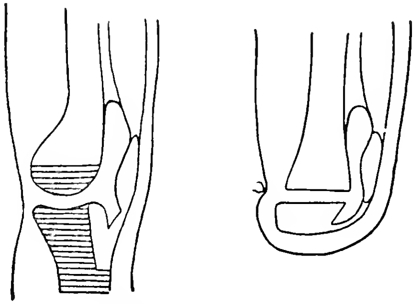


FIG. 428.—Diagrammatic representation of Sabanejeff's operation.

are sutured (Fig. 427). Sabanejeff makes an anterior flap, opens the knee-joint from behind, saws the condyles at their broadest part, takes a bone-flap from the anterior portion of the tibia and fastens it to the femur (Fig. 428).

Amputation of the Thigh.—In high amputation in the *lower third* either a flap or a circular operation may be per-

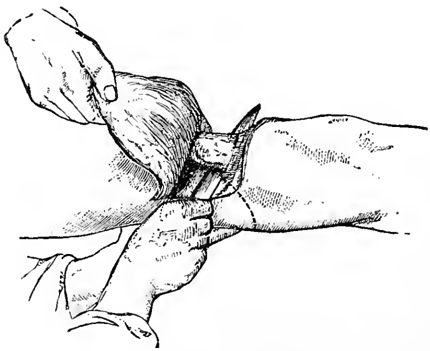


FIG. 429.—Amputation of the thigh (Bryant).

formed. In a douple-flap operation a semilunar skin-incision should be made from without inward, and the muscles should be cut by transfixion (Fig. 429). In the lower third Teale's flap or the long anterior flap may be employed. The amputation by a long anterior flap consists in making a lengthy

skin-flap, reflecting it, cutting the anterior structures to the bone, again entering the long knife at one angle of the incision, pushing it back of the femur, bringing it out at the other angle, and cutting the structures behind the bone directly backward. Bell amputates by a long anterior semilunar flap and a short posterior flap. In amputations in the *upper two-thirds* of the thigh the best plan is to mark out equal anterior and posterior semilunar skin-flaps, divide the skin with a scalpel, enter the long knife at one angle of the anterior flap, bring it out at the other angle, and cut the muscles

Fig. 430.—Macewen's method for compression of the abdominal aorta (*American Text-Book of Surgery*).

by transfixion. Cut the posterior flap in the same manner. Some surgeons prefer a long anterior semilunar flap and a short posterior semilunar flap. The pure circular amputation is not adapted to the thigh.

Disarticulation at the Hip-joint.—Disarticulation at the hip-joint can be affected while the circulation is controlled by Macewen's method of compression of the aorta (Fig. 430). The weight of the assistant's body is thrown upon the patient's aorta by the right fist, placed slightly to the left of the umbilicus. McBurney has suggested the prevention of bleeding by making a small abdominal incision and having an

assistant make direct digital pressure upon the iliac artery. I employed McBurney's method in a recent case and found it most satisfactory. In the *bloodless method of Wyeth* (Figs. 431, 432) the band of the Esmarch apparatus is held up by Wyeth's pins, the outer pin being inserted one and a half inches below and a little internal to the anterior superior spine of the ilium, and brought out just back of the great trochanter. The inner pin is entered one inch below the level of the crotch, and internal to the saphenous opening, and it emerges one and a half inches in front of the tuberosity of the ischium. The hip is brought well over the edge of the table, a circular incision is made down to the deep fascia six inches below the constricting band, and is joined by a longitudinal skin-cut reaching from the band to the level

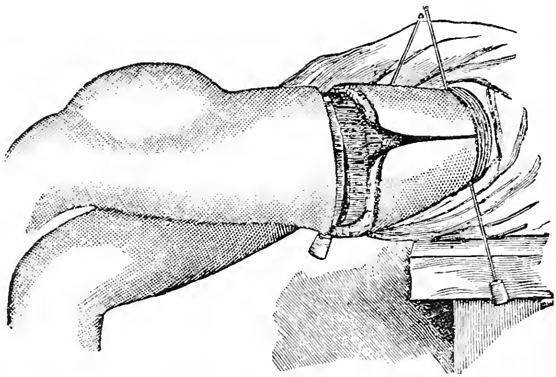


FIG. 431.—Amputation at the hip-joint: Wyeth's bloodless method.

of the circular incision, and the cuff is reflected to the level of the lesser trochanter. The muscles are cut by a circular sweep at the level of the retracted cuff, the capsule is opened freely, the cotyloid ligament is cut posteriorly, the thigh is bent upward, forward, and inward to dislocate the head of the bone, and, using the thigh as a handle, the round ligament is incised and the limb removed. After ligating the vessels and introducing tubes the flaps are sewn together vertically. The old transfixion operation is practically extinct. A T-*amputation* may be employed. It consists of an external straight incision down to the bone, starting over the great trochanter, down the outer side of the limb, and a circular incision through the skin five inches below the constricting band, the muscles being cut by a circular sweep at the level

of the retracted skin. This method affords easy access to the joint. The bloodless method of Wyeth, as applied to the hip-joints and shoulder-joints, is one of the notable modern advances in the art of surgery. Larrey amputated

FIG. 432.—Wyeth's bloodless amputation at the hip-joint: cuff of skin and subcutaneous fat turned back, muscles divided at level of small trochanter, bone partly stripped, and large vessels exposed for deligation.

by lateral flaps, and Liston by anteroposterior flaps. Forneaux Jordan's method consists in dividing the soft parts low down, tying the bloodvessels on the face of the stump, shelling out the femur from the soft parts, and disarticulating.

XXXVIII. DISEASES OF THE BREAST.

Mammillitis and Fissure.—The nipple may inflame as a result of injury, but the condition is rarely encountered except in a woman who is nursing a baby. It is most common after a first pregnancy, when the nipple is deformed or when the skin is delicate. The nipple is slightly injured during nursing, and the epithelium is macerated by the milk and saliva. If the inflammation is not arrested, an area excoriates or an irritable ulcer forms (a fissure). This fissure

is often surrounded by an area of acute inflammation, and nursing causes intense agony. Because of the pain the mother is apt to extend the intervals between nursing, and as a consequence the breasts become swollen with retained milk. The ulcer not unusually bleeds when taken by the child. Besides the fact that a fissure causes pain to the mother, it often leads to grave trouble. It is a suppurating area, and as such may lead to abscess of the mother's breast, or may impair the health of the nursing child.

Prevention of Fissure.—During pregnancy the nipples should be carefully attended to. They should be washed often in sterile water and bathed in alcohol, and if retracted ought to be drawn out repeatedly. During lactation the nipples are washed in sterile water, dried, and dusted with borated talc powder as soon as an act of nursing is completed. Washing the nipples regularly with the following solution tends to prevent the formation of a fissure: iodid of mercury, gr. ij; alcohol, ℥jss; glycerin and distilled water, *āā* a pint (Lepage). If a small abrasion appears, order the woman to wear a nipple-shield during nursing, and after each act of nursing to wash the part with hot sterile water, dry, and dust borated talc over the surface. If a fissure forms, wean the child at once, and dry up the milk in both breasts. It is useless to try to dry it up in one breast. Milk may be dried up by applying ointment of belladonna locally and administering iodid of potassium internally; by strapping the breasts with adhesive plaster (Parker); or by applying to the nipples six times a day a 5 per cent. solution of cocain in equal parts of glycerin and water (Joise). The fissure is not treated by ointments. These preparations are septic, prevent drainage, and aggravate maceration. Wash the fissure twice a day with peroxid of hydrogen, dress it with gauze wet in boric-acid solution (gr. x to ℥j of water), and cover the dressing with waxed paper. If the fissure resists treatment, touch it with lunar caustic.

Acute Mastitis and Abscess.—Acute inflammation of the breast, as a result of injury of the breast or nipple, may occur in either sex at any time of life. Very commonly in both sexes a few days after birth the breast becomes distended with a material which in reality is milk. The fluid is usually small in quantity. The process is physiological, and, as a rule, ceases spontaneously (Guelliot). If it lingers, the application of belladonna ointment will stop secretion. If the nurse meddles with and tries to squeeze out the fluid, acute mastitis is apt to arise in one gland, or occasionally in

both. The skin of the breast reddens, the gland swells and becomes tender and painful, the child loses its appetite and becomes feverish, restless, and sleepless. Such a condition is treated by the local use of lead-water and laudanum. If pus forms, the local signs and constitutional symptoms are aggravated. Evacuate the pus, dress with hot antiseptic fomentations, and be sure that the child is well nourished. Tonics and stimulants are indicated.

A condition identical with the secretory activity of the glands of the new-born may occur in either sex at puberty. The methods of treatment are the same in both cases. As a matter of fact, rarely more than one lobule at this period inflames, and suppuration is most unusual.

Mastitis is most usually met with in a woman who is nursing a child, and is due to bacterial infection. Primipara are particularly liable to develop mastitis. So are women with deformed nipples. In many cases an abrasion of the nipple exists, and through this breach of continuity organisms gain entrance to the breast-tissue. The abrasion may be so slight that it can only be detected when the nipple is examined through a magnifying-glass (Marmaduke Shield). Streptococcic infections are very generally due to inoculation of a fissure of the nipple. Organisms may pass up the milk-ducts, coagulating the milk and penetrating through the walls of the acini. Staphylococci usually adopt this route in reaching the breast-tissue. Occasionally causative organisms reach the breast through the arteries (in septicemia and in septic wounds of the genital organs).

Symptoms.—There are pain, swelling, and tenderness in the breast, and in most cases a fissure or abrasion exists. There is a febrile condition. Occasionally a chill ushers in the attack.

Treatment.—Stop nursing. Arrest the secretion of milk. Treat the nipple as advised on page 1056. Support the breast and apply ichthyol ointment or lead-water and laudanum.

A mastitis may undergo resolution; it may terminate in organization and induration; it may eventuate in suppuration.

Acute abscess of the breast follows an acute mastitis. There may be but one area of suppuration, or multiple foci may exist, which eventually fuse. The symptoms of mastitis, local and constitutional, are greatly aggravated. After a time the skin becomes dusky and edematous. The axillary and superficial cervical glands enlarge. The abscess will eventually open spontaneously at one or more points, leaving

branching fistulæ. A superficial abscess is situated just beneath the nipple, and pus may flow from the nipple.

An intramammary abscess is in the depths of the gland. There are often multiple foci of suppuration. Nodules are felt in the gland, pus may run from the nipple, but cutaneous redness is late in appearing.

Retromammary abscess is a rather rare condition. It may occur alone or be associated and connected with an area of intramammary suppuration. This condition may result from metastasis or from caries of a rib. The breast is lifted up by the fluid beneath it.

Treatment.—Open a superficial abscess by an incision radiating from the nipple. Treat as any other acute abscess. An intramammary abscess should be opened by a radiating incision, and pockets of pus should be broken into with the finger. An examination is made to determine if a retromammary abscess also exists. If this is found to be the case, an incision is made at the point of junction of the thorax and mammary gland, and at the lower border of the gland. The gland is raised from the chest-wall, the pus evacuated, and a drainage-tube is inserted. If retromammary abscess exists alone, make the last-named incision in the first place.

Chronic Mastitis.—This condition may be present in only a portion of the breast, or may attack many lobules (lobular mastitis). The ordinary form may arise after weaning a child, or may be due to a blow, to the pressure of corsets, or to numerous slight traumatisms. It may occur in the young, the middle aged, or the old. The patient has slight pain at times in the gland. Examination detects a firm, elastic area, which is somewhat tender and does not present distinct edges. The skin is not adherent to the mass unless suppuration occurs. If the mass is pressed against the chest by the surgeon's fingers, it becomes evident that no real tumor exists.

Treatment.—Remove any cause of irritation. Support the breast in a sling. Apply ichthyol ointment. During the night employ a hot-water bag. If pus forms, treat as before directed.

Chronic lobular mastitis is a condition in which numerous lobules become indurated. The real cause of this condition is unknown. It may occur at any age after puberty, and often attacks both breasts. Such a breast is apt to be painful, especially at the menstrual periods; it feels unnatural, solid, and careful examination detects numer-

ous indurated areas, each of which is of small size. At the menstrual period the breast enlarges and new nodules may be detected. In some of these cases violent neuralgic pains are present in the gland (mastodynia). Chronic lobular mastitis is apt to lead to cyst-formation. When cysts form fluid may occasionally discharge from the nipple.

Treatment.—Support the breast and apply ichthyol ointment or belladonna ointment. Examine the generative organs and correct any existing abnormality. Improve the general health by good food, tonics, and open-air life. In cases where multiple cysts are known to exist the question of treatment is uncertain. There seems to be no doubt that such cases tend in some instances to eventuate in cancer. We believe that the proper treatment is extirpation of the breast.

Tuberculosis of the Mammary Gland.—(See page 137.)

Cysts and Tumors of the Nipple and the Mammary Gland.—Tumors are rare in the nipple, but do sometimes occur. The following growths are occasionally seen: fibroma, angeioma, papilloma, myxoma, myoma, and epithelioma. Sebaceous cysts of the nipple and areola are not very unusual. A cancer of the nipple may be a primary growth, or may be secondary to gland cancer. Primary epithelioma of the nipple presents the same general characters as epithelioma in any other region. It begins as an indurated area in the areola, or an excoriation of the nipple. Ulceration soon occurs. The ulcer is irregular in outline, has hard edges, furnishes a foul red flow, and the discharge is sanious and fetid. The mammary gland becomes infiltrated at an early period. The subclavian glands enlarge, and later the axillary glands. This growth must not be confounded with a chancre of the nipple.

Treatment of Tumors of the Nipple.—Innocent tumors are to be excised and the breast need not be removed.

Epithelioma of the nipple requires the complete extirpation of the breast, and also the clearing out of the lymphatic contents of the axilla, and possibly of the subclavian triangle.

Paget's Disease of the Nipple (Malignant Dermatitis).—This condition is a chronic inflammation of the epithelial layer of the nipple and areola occurring in women beyond middle life, and is a not unusual precursor of epithelioma of the nipple and of duct cancer. Paget's disease is not a simple eczema, it is not associated with the usual causes and attendants of eczema either local or constitutional, and is not cured by remedies which control the ordinary disease.

The diseased area is raw and red, and from it exudes copiously a thick, yellow discharge. In some cases Paget's disease is secondary to duct cancer, auto-infection of the nipple having been effected by the fluid flowing from the ducts. Investigations have shown the presence of psorosperms in an area of Paget's disease.

Treatment consists of removal of the entire breast and clearing out of the axilla and subclavian triangle.

Tumors of the Mammary Gland.—These tumors may be innocent or malignant. The innocent tumors are

Fibro-adenomata or Cystic Adenomata, Myxomata, Villous Papillomata, and Angiomata.—It is maintained by most authorities that any innocent tumor of the gland may and often does become malignant.

Fibro-adenoma.—The nomenclature of these growths is in a state of great confusion. The name of fibro-adenoma was given by Cornil and Ranvier to the same sort of growth which the younger Gross called a fibroma, Billroth an adeno-fibroma, and Sir Astley Cooper a chronic mammary tumor. It is doubtful if a pure fibroma ever occurs in the mammary gland (Senn). A fibro-adenoma consists of acini surrounded by fibrous tissue. Each of these structures proliferates, but the fibrous tissue does so much more rapidly than the glandular. A growth of this character is surrounded by a capsule, and is movable. It is firm, elastic, lobulated, superficially situated, and of slow growth. It is unassociated with retracted nipple, glandular enlargement, adhesion to the skin, or cachexia, and may occur at any age up to fifty, but is most common between twenty and thirty (J. Bland Sutton). Such a tumor is rarely very painful, but it may be tender on rough handling and may be painful at the menstrual period. As a rule, there is but one of these tumors in a mammary gland, but one may exist in each gland.

Treatment.—Extirpation of the tumor.

Cystic adenoma (**adenocele**) is a rare form of slowly-growing tumor, which is apt to grow to a large size, which is nodular in outline, hard to the touch, and firmly attached to the breast, but mobile upon the chest. A cystic adenoma has a distinct capsule. This form of tumor is painless, and is most apt to occur in women between thirty and forty who have born children. The growth is adherent to the skin, but the cutaneous surface is not discolored, the cutaneous veins are not distended, the axillary glands are not enlarged, and the nipple is not retracted. From the walls

of the dilated acini papillomatous growths are apt to arise (intracystic vegetations).

Treatment.—Removal of the breast.

Myxoma is a rare tumor, and only occurs in a person of middle age. The growth is solitary, is soft, may be round or lobulated, and occasionally fungates. The nipple is not retracted, the superficial veins are not distended, and the axillary glands are not enlarged.

Treatment.—Removal of the mammary gland.

Angioma.—This form of tumor is very rare. It may arise secondarily to a nevus of the skin (Sutton). The diagnosis of angioma of the skin is readily made. In a cavernous angioma of the breast it will be found that the tumor can be lessened in size by pressure, and will be increased in size by coughing, laughing, and holding the breath. Pulsation may be detected and a bruit may be audible.

Treatment.—For treatment of nevus see page 283. If a cavernous angioma exists in the mammary gland, it will be necessary to extirpate the gland.

Cysts of the Mammary Gland.—**Involution cysts** (cystic degeneration of the mamma) occur in women who are approaching the menopause. They occur earlier in those who are sterile than in those who have born children, and may arise after chronic mastitis. The parenchyma of the gland undergoes atrophic change, but the ducts remain, become blocked and dilated. Numerous small cysts form, and both glands, as a rule, suffer. Villous growths may arise in the walls of the ducts. In some cases there is much white fibrous tissue between the cysts (cystic fibroma).

The subjects of this disease are often nervous, hysterical, and despondent. One or more ill-defined indurations are detected. Frequently there is a history of discharge from the nipple and of attacks of lancinating pain in the breast. Cystic breasts are dangerous, because the intracystic vegetations are liable to eventuate in duct cancer.

Treatment.—In such cases, after confirming the diagnosis by an exploratory incision, remove the entire breast (Snow).

Lacteal cyst (**galactocele**) is an accumulation of milk brought about by blocking of some of the milk-ducts. It arises soon after the delivery of the child, and grows rapidly. A large quantity of milk may collect, and rupture of the cyst-walls can occur, the fluid passing into the glandular connective tissue.

A galactocele is rounded, fluctuates distinctly, and increases in size during nursing. There is little or no pain. In some cases the contents of the cyst coagulate and a solid mass is formed.

Treatment.—Incision and drainage.

Hydatid cysts are rare, but do occasionally occur.

Treatment.—Excision.

Malignant tumors of the mammary gland are ten times more common than innocent tumors.

Sarcoma.—Sarcoma of the mammary gland is a very rare growth (less than 10 per cent. of breast tumors). It may occur at any age from puberty to old age, but is most common from twenty to thirty-five. The growth may be composed of round cells or spindle cells, both varieties may be present, and myeloid cells may be found. Circumscribed sarcoma arises usually between the ages of twenty and thirty; it is firm to the touch, as it contains much fibrous tissue, is painless, does not grow very rapidly, glands are not involved, and there is no cachexia. The nipple is not retracted. The growth may adhere to the skin. It is composed of giant-cells or spindle-cells, and rarely returns after extirpation of the breast.

Diffused sarcoma is composed of small round cells, arises in the center of the breast, and grows with great rapidity. It is most commonly met with about the age of thirty-five, and a history of injury can often be elicited. The tumor is soft, some parts being softer than others because of cyst-formation. It is usually mobile upon the thorax, though it soon becomes adherent to the skin. The tumor reaches a very great size, and soon fungates through the skin. There is little or no pain. The cutaneous veins over the tumor are distended, the nipple is not retracted, and the axillary glands are not often enlarged. Diffuse sarcoma is apt to recur after removal.

Treatment.—Remove the breast, and if the muscles of the chest-wall are infiltrated, remove them. The axillary glands are removed if they are enlarged, but not otherwise. Operation will not cure when metastases exist. If the case is inoperable, we can try the use of Coley's fluid. If the toxins of erysipelas fail to arrest the progress of the disease, keep the patient as comfortable as possible by the administration of cocain and morphin.

Carcinoma or Cancer of the Mammary Gland.—The great majority of mammary tumors belong to the genus carcinoma. Cancer is due to proliferation of the epithelium of the acini (acinous cancer) or of the ducts (duct cancer).

Acinous cancer is vastly commoner than duct cancer. Usually there is much connective tissue and but little parenchyma in the growth (scirrhus cancer). In some cases there is little connective tissue and much parenchyma (encephaloid or medullary cancer). If colloid degeneration of the parenchyma or stroma occurs, the growth is spoken of as colloid cancer.

Scirrhus, the common form of acinous cancer, is almost as hard as stone. On section it is concave, and Sutton says "resembles an unripe pear." The tumor is without a capsule, and the epithelial cells are surrounded by masses of fibrous tissue. Portions of tissue, even some distance away from the tumor, contain foci of proliferating embryonic epithelial cells. In atrophic or withering scirrhus the fibrous stroma contracts and epithelial cells undergo fatty degeneration (Senn).

Causes and Symptoms.—*Scirrhus* is more common among women who have born children than among those who have not. Heredity is manifest in only about 10 per cent. of cases (Bryant). The younger Gross found it in one case out of nine. Trauma has no apparent influence in producing cancer. The disease is rare before the age of thirty-five, and is most common between forty-five and fifty. The author operated for scirrhus of the breast on a woman only twenty-seven years of age. Henry saw a woman of twenty-one with cancer. It is frequently met with in the aged. These tumors are rare in the negro race. A hard nodule is found in the breast, usually under the nipple, but possibly far away from it. The growth is nodular, and is immobile from the beginning. In a large, fat breast there is often a deceptive sense of mobility, because some of the breast-tissue moves with the tumor. The cancer may have been present for a considerable time before being discovered. In obscure lesions of bones and viscera examine the mammary glands, because the trouble might be due to metastasis from an undiscovered carcinoma of the breast. Retraction of the nipple is present in over one-half of the cases (S. W. Gross). It occurs when the growth is near the nipple, and is due to the contracting fibrous tissues of the tumor pulling on the milk-ducts. If the growth is far away from the nipple, a dimple is apt to form on the skin of the breast because of the pulling upon the suspensory fibers.

Glandular enlargement in the axilla soon follows the appearance of a scirrhus; the glands become very hard and adherent. In over 60 per cent. of persons the glands of the

axilla are felt to be enlarged when the patient first comes for treatment. Because the surgeon cannot feel enlarged glands is no proof that there are none. As a matter of fact, the glands are usually involved within two months of the beginning of the disease, but the involvement can rarely be detected externally until months later. Enlargement of the axillary glands is followed by enlargement of the glands in the posterior cervical triangle and in the mediastinum. Herbert Snow has shown that the blocking of the axillary glands often leads to regurgitation of lymph containing cancer-cells, the cells being thus deposited in the head of the humerus and the thymus gland. Cells in the thymus, after a time, cause a projection of the sternum (the sternal symptom). When the axillary lymphatics are extensively involved the arm swells from obstruction to the lymph-flow (lymph edema) or pressure upon the vein. The tumor usually grows rather slowly unless lactation is established, then it grows rapidly. As it grows it infiltrates adjacent structures (the pectoral fascia, pectoral muscles, subcutaneous cellular tissue, and skin). When the skin is destroyed an ulcer forms, and around this ulcer the skin becomes red and filled with cancerous nodules, which feel like shot in the skin. Metastases are apt to occur into the bones, liver, brain, pleura, spine, thymus gland, and rarely the eye.

Pain is usually present in scirrhus carcinoma. It is lancinating and neuralgic in character, and not brought on or increased by handling. It ceases if colloid degeneration begins. The general health is usually unimpaired until ulceration takes place, when cachexia arises. The *cancer en cuirasse* of Velpeau is a condition in which the lymphatic vessels of the skin are extensively invaded, the growth itself being adherent to the wall of the thorax. In this condition the chest-wall is fixed, respiration is difficult, and the temperature is commonly somewhat elevated.

In *atrophic* or *withering scirrhus* the contraction is so great that it seems as though the mammary gland had been removed. The duration of scirrhus, when left to run its course, varies, but the disease generally produces death within two and a half years. Occasionally it causes death within a year. In atrophic scirrhus the patient may live for many years.

Duct cancer is not a common growth. It arises from the duct-walls in conditions of cystic degeneration of the mammary gland. The tumor is softer than the acinous growth, and is not nodular. There is no pain, no retraction of the

nipple, no skin dimple. Serous or bloody fluid may often be squeezed from the nipple. A duct cancer grows, infiltrates slowly, and involves adjacent glands later than does scirrhus.

Treatment of Carcinoma of the Mammary Gland.—The treatment is early and thorough operation, the earlier and the more thorough the better. The older surgeons operated simply to prolong life a few months; the modern surgeon operates with the hope of curing the patient. In 1878, Billroth's statistics showed only 8 cures in 143 cases. In 1896, W. Watson Cheyne reported 12 cures out of 21 cases (57 per cent.). The operation should remove the breast and much of the skin above it, the pectoral fascia, and often the pectoral muscles; the fat and glands of the axilla, and sometimes the fat and glands of the subclavian triangle. If three years after an operation there has been no return, we regard the case as cured (Volkmann's limit). Certain cases are unsuited for a radical operation: cases in which metastases exist; cases of *cancer en cuirasse;* cases where axillary involvement is very great. Cheyne would also rule out cases where large glands may be felt above the clavicle, believing that in such cases the mediastinal glands must be cancerous.[1]

Halsted's Operation.—Halsted performs a very radical operation. He removes suspected tissue in one piece, and thus prevents carcinoma cells falling in the wound, for it is well known that if such cells should fall into the wound they may grow just as may a graft of healthy epithelium. The neck, shoulder, the arm to the elbow, the entire surface of the chest down to the waist, the breast itself, the axilla, the side and the back must be sterilized. It is necessary to have, besides scalpels, and the ordinary instruments for an operation, a great number of hemostatic forceps (80 to 100). Place the patient recumbent, with a sand-pillow under the shoulder of the affected side. The shoulder is right at the edge of the bed, and a nurse holds the arm from the side. Halsted describes his operation as follows:[2] The skin incision is made as shown in Fig. 433, and is carried at once through the fat. The triangular skin flap (*a*, *b*, *c*,) is turned down. The costal insertions of the great pectoral muscle and the muscle are split between the clavicular and costal portions and up to a point on the clavicle opposite to the scalene tubercle, and at this point the clavicular portion of the muscle and the tissue overlying it are cut through close

[1] See *Objects and Limits of Operation for Cancer*, by W. Watson Cheyne.

[2] *Johns Hopkins Hosp. Reports*, vol. iv.; *Annals of Surg.*, Nov., 1894.

to the clavicle, and the apex of the axilla is at once exposed. The cellular tissue under the clavicular portion of the muscle is dissected from the muscle, and the splitting of the muscle is continued on to the humerus. The part of the muscle to be removed is cut through close to its humeral insertion. The whole mass circumscribed by the first incision (skin, breast, areolar tissue, and fat) is raised with considerable force in order to put the submuscular fascia on the stretch as it is stripped from the thorax close to the ribs. It is well to include the delicate sheath of the pectoralis minor muscle. The lower and outer boundary of the lesser pectoral having

FIG. 433.—Halsted's operation for carcinoma of the breast: the first incision.

been passed and exposed, the muscle is cut at a right angle to its fibers and a little below the middle. The tissue over the minor muscle near its coracoid insertion is divided as far out as possible, and is then reflected inward to prepare for the reflection upward of this part of the minor muscle. The upper portion of the minor muscle is retracted upward (Fig. 434). The small blood-vessels under the minor muscle are carefully separated from it, are dissected out very clear, and are ligated close to the axillary vessels. Having exposed the subclavian vein at the highest possible point below the clavicle, the contents of the axilla are dissected away with a sharp knife and the vein and its branches are stripped absolutely clean. The loose tissue about the artery and the nerves should also be removed. When the vessels are cleared the axillary contents are rapidly stripped from the inner walls of the axilla and the lateral wall of the

thorax. The fascia which binds the mass to the chest is cut close to the ribs and the serratus magnus muscle. Just before reaching the junction of the posterior and lateral walls of the axilla, an assistant draws the triangular flap of skin outward in order to spread out the tissue which lies upon the subscapularis, teres major, and latissimus dorsi muscles. The operator cleans the posterior wall of the axilla from within outward. The subscapular vessels are clearly exposed, and are caught before they are cut. In some cases the subscapular nerves are removed, in others they are permitted to remain. Having passed these nerves the mass

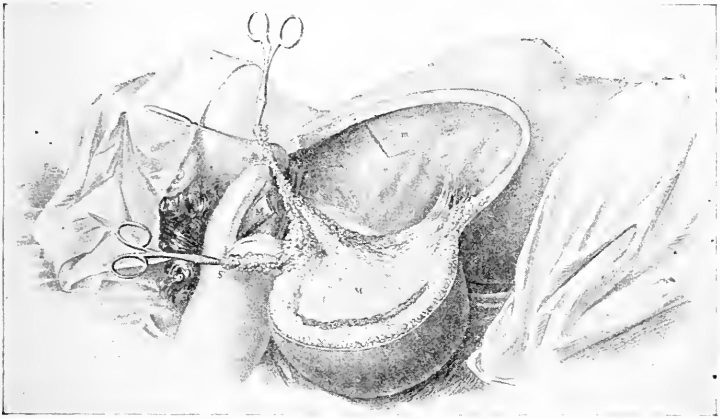


FIG. 434.—Halsted's operation for carcinoma of the breast: the mass turned down.

is turned back into its normal position and severed from the body of the patient by a stroke of the knife from *b* to *c*, repeating the first cut through the skin. Every bleeding point, however small, is tied with fine silk, from 60 to 100 ligatures, or even more, may be required.

After the completion of the operation the wound into the axilla is closed with a subcuticular stitch of silver wire; if a cut has been carried above the clavicle, it is closed in the same manner, and the edges of the elliptical opening are brought nearer together by a purse-string subcuticular stitch. Thiersch grafts cut from the patient's thigh are used to cover the gap. Silver foil is placed over the wound, this is covered with gauze, bandages are applied, and the dressing is overlaid by a plaster-of-Paris bandage, which includes the head, neck, chest, and arm. The area from which grafts were taken is dressed with sterile gauze or an ointment containing boric acid.

A very useful incision is that described by the younger Senn, and shown in Fig. 435. The breast is circumscribed by two curvilinear incisions which meet above, at the border of the great pectoral muscle. The incision is continued a little internal to the outer border of the muscle to about one inch above the apex of the axilla, when it is curved outward in the deltoid region, and terminates at the level of the apex of the axilla. The breast is removed from the wall of the chest, and is then suspended by axillary glands and fat, which are removed *en masse*.[1] This incision gives a free exposure, opens the axilla from in front, enables the surgeon to quickly locate and freely expose the axillary vein, and the resulting scar does not limit materially the motions of the arm.

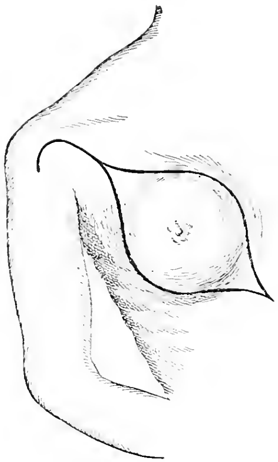


FIG. 435.—The younger Senn's incision for amputation of the breast.

XXXIX. SKIAGRAPHY, OR THE EMPLOYMENT OF THE RÖNTGEN RAYS.

The cathode rays were discovered by Hittorf, in 1869, while passing an induction current through a vacuum-tube. Crookes of London greatly improved the vacuum-tube, and obtained a rarefaction which left in the tube but the one-millionth of an atmosphere. This last-named observer found that when an interrupted current of high potential is passed through a vacuum which is nearly perfect, fluorescence takes place. In a Crookes tube the positive electrode is placed at some indifferent point, and the current from the negative electrode flows not to the positive, but directly to the wall of the tube opposite the cathode, and at this point the phosphorescent glow is detected.

In 1895, Röntgen of Würzburg, while making a study of cathode rays as developed in Crookes's tubes, discovered the energy which he named the *X*-rays. Röntgen showed that at the wall of the Crookes tube opposite the negative electrode a new and hitherto unknown energy is generated. Because of the uncertain character of this energy

[1] See the younger Senn in *Jour. Am. Med. Assoc.*, May 27, 1899.

he gave to its manifestation the name of the *X* or unknown rays.

The *X*-rays are invisible; cannot be deflected, reflected, refracted, or concentrated; are not influenced by the magnet; and produce none of the ordinarily recognized effects of heat. They cause fluorescence in certain substances, notably in tungstate of calcium (Edison), platinocyanid of barium (Röntgen), and platinocyanid of potassium. They have a marvellous power of penetration, and pass through many substances which are opaque to sunlight, ultraviolet light, and ordinary electric light. They are readily transmitted by water, organic substances, leather, cloth, paper, and flesh. Bone transmits them less easily, and metal still less easily, but no substance absolutely prevents their transmission. An ordinary dry photographic plate is sensitive to the rays. If the rays are intercepted by a body not readily permeable which is placed between the Crookes tube and the photographic plate, a shadow will be cast, and a picture of this shadow will be formed upon the plate. Such a picture is known as a skiagraph or radiograph. If a body more or less resistant to the rays is placed between the tube and a fluorescent screen, the body casts a shadow on the screen, and the portion of the screen free from shadow glows with fluorescence. Such a screen is known as a fluoroscope. It will thus be seen that the *X*-rays enable the surgeon to look beneath the skin and to see those things which before the discovery of Röntgen were unseeable during life.[1]

The real nature of the *X*-rays is unknown. They are not heat-rays; they are not ultraviolet rays. Röntgen thinks they are longitudinal ether-waves. Monell says, "They appear to be originated at the site of the greatest electrical activity within the tube, and their real nature is as unknown as the nature of heat, gravity, electricity, mind, and of life itself."

To obtain the rays a good apparatus is essential. An ordinary medical battery is incapable of producing them, as it is absolutely necessary to have a current of high tension. The discoverer used a Ruhmkorff coil, but this is by no means the most satisfactory apparatus to employ. Some experimenters have made use of a "powerful static machine and transformer coils" (Monell). Swinton uses twelve half-gallon

[1] See Röntgen's report to the Physico-Medical Society of Würzburg, Dec., 1895; also the article upon the *X*-rays by S. H. Monell, in the *Brooklyn Medical Journal*, May, 1896.

Leyden jars and discharges them through the primary coil, the secondary circuit being a Tesla oil coil.

The current is best taken from the street-light circuit. Monell says that this current should be controlled by an interrupter, the interruptions of which are 100 per second. The interrupted current is to be passed into an induction coil, and the secondary current is to be conveyed into the Crookes tube by two wires. The secondary current thus produced will furnish a spark five or six inches long.

When the surgeon is about to use the *X*-rays, he must remove from the person of the individual anything that might cause confusion or lead to error. If the foot is to be examined, remove the shoes, because shoes contain nails; if the hand is to be examined, remove the gloves if they are fastened with buttons of bone or metal; if the thigh is to be examined, remove coins, keys, knives, etc., from the pocket; a garter, if it has a metal clasp, should be taken off.

In order to get the best results from the Röntgen rays, not only must the apparatus be good, but the man who uses it must be expert. Pictures taken by an unskilled man lack clearness of outline, and may even lead to positively erroneous conclusions. Nevertheless, a person used to the employment of scientific apparatus can very soon become sufficiently expert to take fairly clear pictures which should not lead to error. Morris H. Richardson[1] maintains that the Röntgen rays can be employed successfully in the routine office practice of a general practitioner.

The surgeon may utilize the *X*-rays by means of a fluoroscope. Edison's fluoroscope consists of four sides of a box, one end being open and made to fit tightly over the observer's eyes, the other end being closed with cardboard made fluorescent by smearing it with mucilage, and, before the mucilage is quite dry, sprinkling it with crystals of tungstate of calcium. If it is desired to examine the hand with a fluoroscope, the extremity is held opposite an excited Crookes tube and from six to ten inches away from it, the end of the fluoroscope which is covered with fluorescent paper is placed near the surface of the hand which is away from the tube, and the observer looks through the other end of the instrument. The flesh seems but a dim haze and the shadows of the bones are distinctly outlined. The fluoroscope can be easily used, and gives reliable results in studies upon the hands and feet, but when deeper structures are to be investigated, or when absolute accuracy is

[1] *Medical News*, Dec., 1896.

essential, it is better to take a skiagraph. The value of fluoroscopy is constantly increasing as better electrical appliances and Crookes's tubes are being made.

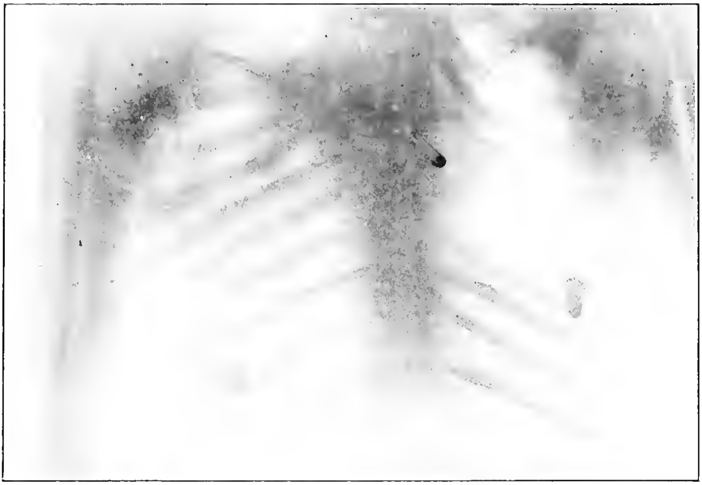
If thick tissues require to be penetrated by the rays, if great accuracy is necessary, or if a permanent record is to be retained, a skiagraph must be taken. In taking these pictures dry plates can be used; the plate need not be removed from its wooden case during the process, and it is not necessary to conduct the proceeding in a dark room. The tube should be from twelve to fifteen inches away from the surface of the body. The plate must be fastened to the surface *exactly opposite* the tube. It is necessary to observe care in the adjustment of the plate, because the *x*-rays travel only in straight lines, and any carelessness of adjustment will lead to curious and misleading aberration in the picture. The length of exposure necessary varies with the thickness of the tissues, the structure of the part, the nature of the body we wish a picture of, and the perfection of the apparatus, from three minutes to one hour. Prolonged exposure is undesirable if it can be avoided, as it may produce an *x*-ray "burn." The use of an improper apparatus or placing the tube too close to the body, may be followed by a burn. Occasionally, in spite of the utmost care, injury will be done by the *x*-rays.

The so-called *x*-ray "burn" is not a burn at all. A burn is due to the contact of heat, begins upon the surface, is accompanied with pain from the moment of application, and is followed by inflammatory changes, beginning on the surface. An *x*-ray "burn" is not manifest for several days or even several weeks after the application of the rays, at which period an inflammatory or a gangrenous process arises, which begins within the tissues and subsequently involves the surface.[1] Inflammation may pass away or may eventuate in gangrene, and a gangrenous area is white in color, "leathery, stringy, tough" (Hopkins). Hopkins calls the process "white gangrene."[2] These burns are often accompanied by loss of hair or nails in the damaged area, they require months to heal, if they heal at all, are very painful, and are not improved by the treatment which relieves ordinary burns. In some cases the consequences are very serious. In a case reported by J. P. Tuttle, it became necessary to amputate the thigh.[3] The lesions occasionally produced by

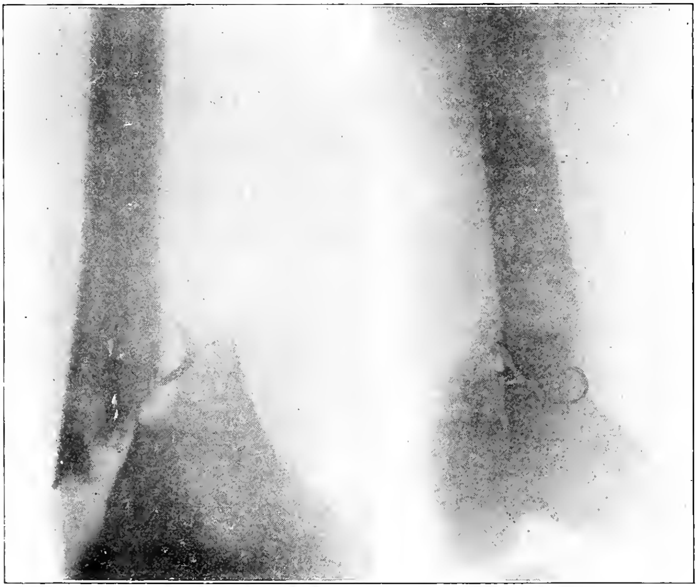
[1] E. B. Bronson, in the debate on J. B. Tuttle's case, *Medical Record*, March 5, 1898. [2] G. G. Hopkins, *Philada. Med. Jour.*, January 6, 1900.
[3] *Med. Record*, May 5, 1898.

the *x*-rays are probably trophic changes. Sections made by Vissman from Tuttle's case indicated that the lesion was a gangrenous process due to arteritis of the smaller vessels. Various theories have been advanced to account for the occurrence of *x*-ray gangrene, viz.: liberation of ozone in the tissues (Tesla); interference with cellular nutrition caused by static electric currents "induced by the introduction of the patient's tissues into the high potential induction-field surrounding the tube" (Leonard); the destruction of the nerve-supply of the tissue (Hopkins); irritation of the peripheral extremities of the sensory nerves, causing paralysis of the vasomotors (Rudis-Jicinsky); an electrolytic action of a current generated in the tissues by induction from the tube (Judd). These *x*-ray injuries are most liable to occur when a Ruhmkorff coil is used, and such a condition is very rarely caused by a static machine. Hopkins says the lesions "are produced more frequently by tubes that are energized by alternating currents than by those energized in any other way." He has only found record of four cases produced when a static machine was used. It has been suggested that a thin piece of aluminum, a plate of platinum, or a sheet of gold-leaf, placed upon the part while it is exposed to the *x*-rays will prevent the occurrence of these injuries. Skin-grafting may succeed in remedying an ulceration following an *x*-ray injury; but, as a rule, the grafts do not grow, or if they adhere are very apt to break down after a time. In many cases the best treatment is excision (Powell).

The uses of the *x*-rays are legion. They are of the greatest possible value in the location of foreign bodies, especially bodies of metal, glass, or bone, such as bullets, and needles, glass, splinters, etc. Bullets are readily detected in the extremities; have been found in the lung-substance and bronchi (Rowland), in the brain (Schier, Brissaud and Londe, Henchen and Sennauer, Bruce, Willy Meyer), in the abdomen, the pelvis, a joint, the spine, and the eye. The *x*-rays will enable us after an abdominal operation to locate a Murphy button and tell when it has loosened and descended. Foreign bodies, especially if metallic, in the esophagus, stomach, intestine, and air-passages; enteroliths and mineral calculi in the salivary ducts, bladder, ureter, and kidney can be detected. Henry Morris tells us that a calculus in the kidney may exist and yet escape detection with the rays, because the kidney is very deeply placed, is under the ribs and close to the vertebral column. Occasionally a drainage-tube lost in the pleural



1



2 3

1. Gunshot-wound of the Lung. Rib-resection for secondary hemorrhage into the pleural sac ten days after the injury; bullet not removed. Hemorrhage arrested by packing with gauze. Skiagraph taken three months afterward shows the bullet. (Author's case.)

2. Fracture of Lower End of the Femur. Reduction of fragments impossible because of the interposition of a loose piece of bone and much muscle between fragments. (Author's case.)

3. Case shown in Figure 2, Three Months after the Operation of Wiring. Nine months after operation, the man is walking about with ease, and the wire is still in place.

(The above skiagraphs are from the X-Ray Laboratory of the Jefferson Medical College Hospital.)

sac may be discovered. Most observers state that gall-stones cannot be skiagraphed in the living body. Cattell has succeeded in one case. Carl Beck has succeeded in skiagraphing cholelithiasis.[1] The rays may fail to disclose a foreign body because of its being overshadowed by a bone (Carless), but prolonged exposure or the taking of another picture with the part in another position will bring it into view. In many cases a skiagraph does not indicate how deeply in the tissues a foreign body lies, or upon which side of a bone it is lodged.[2]

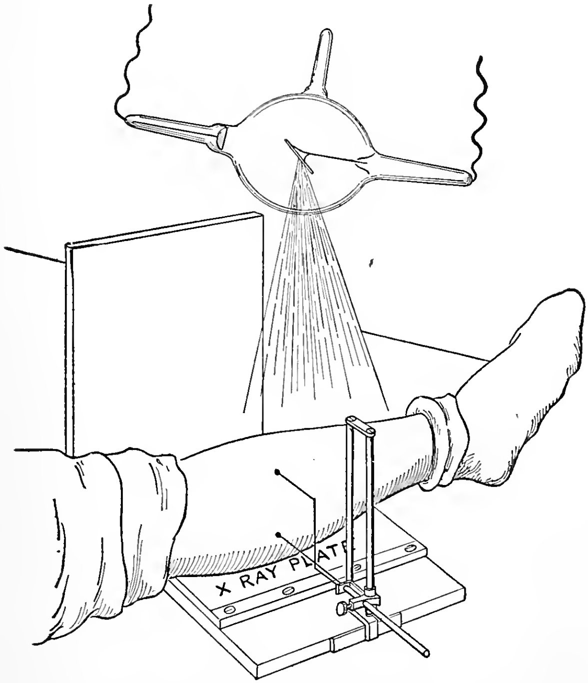


FIG. 436.—W. M. Sweet's *x*-ray apparatus for locating foreign bodies.

If there is doubt, take several pictures from different positions (triangulation), skiagraph over a surface marked in squares, insert guide-needles into the tissues before taking the final picture, or employ Sweet's apparatus. Sweet's apparatus has been used successfully for the location of foreign bodies in the eye, but a modification of the original apparatus has recently been used to skiagraph other regions of the

[1] *N. Y. Med. Jour.*, January 20, 1900.
[2] Battle's case in *Lancet*, February 29, 1896.

body. Sweet's apparatus is used as follows:[1] "The essential features of this apparatus and the method of employing it are shown in the illustration (Fig. 436). An adjustable arm carries two ball-pointed rods which are at a known distance apart, and are parallel with each other and with the photographic plate, while the balls are perpendicular to each other and the plate.

"When the skiagraphs are made, one of the indicator-balls rests against the skin at any point in the neighborhood

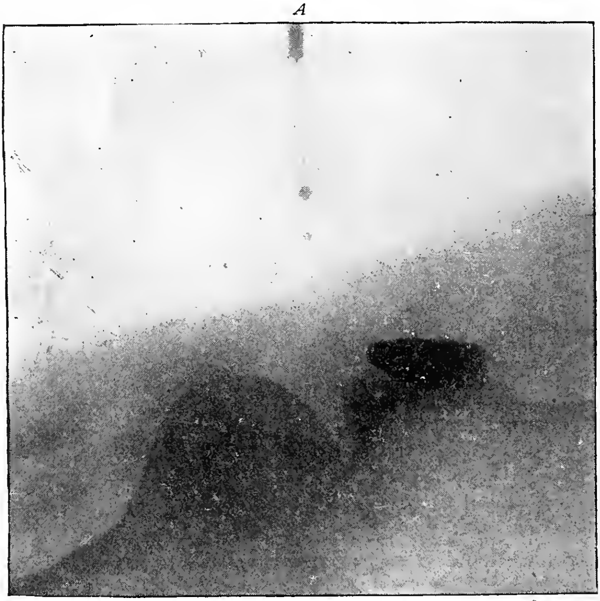


FIG. 437.—Skiagraph made with tube horizontal to plane of indicators. The bullet is well seen. Opposite *A* are seen the two balls at the ends of the rods.

of the foreign body, while the second indicator is toward the plate. The spot on the skin at which one of the indicator-balls rests is marked with silver nitrate, as the position of the foreign body is measured from this point.

"Two skiagraphs are made to give different relations of the shadows of the two indicators and the bullet, one exposure with the tube horizontal, or nearly so, with the plane of the indicators, and a second exposure with the tube at any distance above or below this plane. Since the shadow of the foreign body preserves at all times a fixed relation with

[1] W. W. Keen, in *Philada. Med. Jour.*, January 6, 1900.

respect to the shadows of the two indicator-balls in whatever position the tube is placed, and since the situation of two balls is known, the location of the foreign body in the tissues is readily determined from a study of the planes of shadow at the two exposures.

"When the skiagraphs of the case here reported were made, the anterior surface of the leg was placed upon the bottom of the right-angle support of the apparatus, the plate to the inner side of the knee, one indicator-ball resting on the skin nearly in the center of the popliteal space. The

FIG. 438.—Skiagraph made with tube above horizontal plane of indicators. The bullet is well shown. Opposite *A* and *B* are seen the two balls at the ends of the rods.

skiagraph made with the tube horizontal with the plane of the indicators is shown in Fig. 437, and the second skiagraph with the tube a short distance above the first position is seen in Fig. 438. Both negatives show the leg as viewed from the outer side, with the posterior surface of the leg uppermost.

"In determining the position of the bullet a spot is made upon paper to indicate the point on the skin at which one of the indicator-balls rested at the time of the exposures, a second spot being made two inches from the first, to repre-

sent the fixed distance between the two balls. These are shown at *A* and *B*, upper diagram, Fig. 439. The first negative is now taken. The distance the shadow of the bullet is below the shadow of each of the two indicators is measured, and this distance entered below the spots representing the two balls when the exposure was made (*C* and *D*). A line drawn through these points indicates the plane of shadow of the bullet when the first skiagraph was made. Similar measurements are made from the second negative and marked below the spots *A* and *B*, the line through the spots (*F* and *H*), giving the plane of shadow when the second negative was made. Where these two planes of shadow cross (*X*) is the position of the bullet as measured below, and to the inner side of the nitrate of silver spot on the skin.

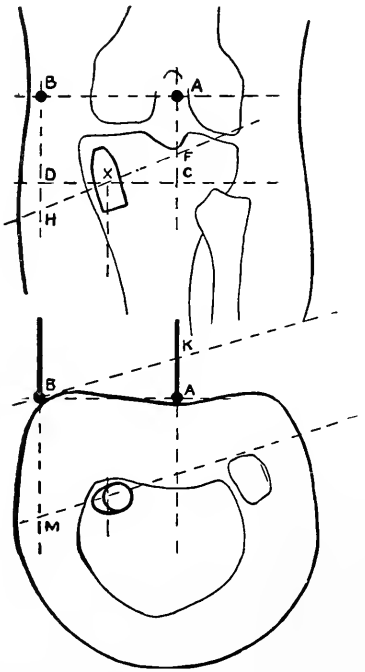


FIG. 439.—Method of indicating location of bullet. Upper diagram, posterior view of leg from above. Lower diagram, cross-section of leg, near knee-joint.

"In determining the depth of the bullet in the tissues, a second diagram is made to indicate the position of the two balls, as viewed from a cross-section of the leg. Since the tube was only twenty-four inches away at the time of the exposure, the convergence of the rays in an object as large as the leg must be allowed for. This is done by measuring the distance the shadow of one ball is behind that of the other, entering this distance (*A K*) on the diagram, and marking on a line through this point, twenty-four inches from the ball resting on the skin, the situation of the tube. If we now measure the distance the shadow of the bullet on the first negative is back of that of the shadow of the ball on the skin, enter this distance in the plane of this indicator (*B M*), and draw a line from the situation of the tube through this point, we obtain the plane

of the shadow of the bullet when the exposure was made. Drawing a line from the position of the bullet as previously found on the first diagram the intersection of this line with the plane of shadow upon the second diagram gives the situation of the bullet from a cross-section view of the leg. For purposes of greater clearness, outlines of the leg have been shown in the two diagrams, although this is unnecessary in practice, since the position of the foreign body in respect to a known point upon the integument is all that is required. The position of the bullet was shown to be one inch toward the inner side of the spot on the skin at which one of the indicator-balls rested, one and a quarter inches below this spot, toward the ankle, and embedded in the tissues to the depth of one and a half inches. Both skiagraphs show the bullet close to the bone, but, owing to the false projection, so common in all *x*-ray pictures, it is impossible to say whether the bullet was embedded in the bone or not."

In detecting fractures and dislocations the Röntgen rays are of great value, especially when there is much swelling, when there is little displacement, and when the fracture is in or about a joint. The rays enable us to determine the nature of the injury, the amount of splintering, the existence of impaction, the question whether or not the fragments are in contact and can be brought into contact; the direction of the line of fracture, the variety of deformity, the existence of more than one fracture, the presence of epiphyseal separation or dislocation alone or with a fracture, the existence of an ununited fracture, and the question if the splints are holding the fragments in accurate apposition. Fractures of the skull, if involving both tables of the vault, may be recognized; it is possible that fractures of the inner table may be found; fractures of the base can be seen, but with difficulty (White). Fractures of the spine never show very clearly. To take a picture of a fractured rib, first limit chest-motion by bandaging (White). Morris tells us to be somewhat skeptical in accepting unreservedly the evidence offered by a skiagraph, as slight carelessness in taking the picture may mean great distortion and consequent error. The *X*-rays may be of value in enabling the surgeon to recognize rheumatoid arthritis; bone- and joint-tuberculosis (the tubercular area being lighter than the sound bone); the amount of acetabular rim present in congenital dislocation of the hip-joint (Rowland); the state of the bones in a crushed limb (J. Hall Edwards); bone deformity; osseous tumors; bone displace-

ment (as in Morton's foot); osteomyelitis; caries; necrosis; and osteosarcoma. By skiagraphy we are enabled to decide on the proper situation to perform osteotomy, and if a deformity of the foot can be amended without operation (Willard). The position of the fetus in utero can be definitely made out.

Applied to the soft parts, the new process has obtained interesting but not as yet many practically useful results. Fibrous tumors can be seen, but malignant tumors, unless they contain calcareous or fibrous elements, cannot be definitely made out; loose bodies in a joint can often be detected. The shadow of the heart can be made out, and the outlines of the diaphragm, kidney, and liver can be thrown upon the screen. If the stomach is distended with gas, it shows as a light area upon a dark background (Hedley). If food is eaten after being mixed with subnitrate of bismuth, the outline of the viscus becomes fairly distinct. Thickened pleura, pleural effusion, pulmonary consolidation, pericardial effusion, aortic aneurysm; cavities in the lungs, and atheromatous blood-vessels may be made out with more or less distinctness. If a sinus is injected with iodoform emulsion, a picture of it can be taken, because the emulsion casts a shadow when placed in the path of the *X*-rays (J. Hall Edwards). Up to the present time no positive evidence has been offered to prove that the Röntgen force is possessed of any therapeutic value.

XL. INJURIES BY ELECTRICITY.

Effects Produced by Lightning.—An individual may be struck directly, or he may be shocked by an induced current, the lightning having struck a nearby object. A person can be struck while in a room, but there is more danger when exposed especially in the open country. To be under a single tree during a thunderstorm is dangerous, but to be in a wood or under a hedge is reasonably safe. The victim of lightning may be killed instantly. Death is the fate of over one third of those struck. Tidy states that out of 54 cases, 21 died and 33 recovered. Postmortem examination may fail to reveal a lesion, but in many cases severe burns are discovered; in some there are laceration of tissue, crushing of bones, and fearful injury. Burns are especially apt to occur at the points where the current entered and emerged. The clothes are usually singed and torn. The typical lightning-marks are arborescent tracings, representing the course of blood-vessels, produced

by disorganization and effusion of blood as the fluid travels through it. Occasionally metal objects, such as buttons, knives, money, keys, etc., are fused, and spread as a metallic film over a considerable portion of the surface of the body. Bichat stated that in death from lightning rigor mortis does not occur. This statement is now known to be an error (see the three cases reported by M. Tourdes). As a rule, there is early vigor mortis, retained fluidity of blood, and distention of the brain with venous blood. The cause of death by lightning was supposed by Hunter to be due to destruction of muscular contractility, and by Richardson to the resolution of the blood into gases. It seems probable that some deaths are due to actual disorganization of vital structure and that others are due to shock or inhibition. In many cases struck by lightning recovery will take place even when the individual is *apparently* dead. Sestier reported 77 cases struck by lightning, and in 7 of them the persons were apparently dead for a number of hours.[1] Brouardel says in such cases the death-like state may be ascribed to inhibition, caused by a *maximum* degree of stimulus.[2] When death from lightning is not immediate the condition may be as above outlined, the individual being apparently dead, without obvious respiration or pulse. He may be insensible, with slow and labored respiration, a weak and irregular pulse, and dilated pupils, and may remain in this condition for a few minutes or for several hours. The above condition is not to be distinguished from severe concussion of the brain. Every individual suffering from the effects of lightning should have his entire body carefully examined to see if physical injuries exist (fractures, wounds, burns, ecchymoses, arborescent tracings). The consequences of lightning-stroke are many and various. There may be rapid and complete recovery, gradual recovery, traumatic neurasthenia, sloughing burns, partial paralysis, which is usually recovered from (Nothnagel), but which may be permanent, hysteria, blindness, change of character, and actual insanity.

Treatment.—Do not pronounce a person dead until a thorough attempt at resuscitation has been made. Do not give alcoholic stimulants. If the respiration is feeble and apparently absent, make tongue traction and artificial respiration. Apply the stream of a cold douche to the head, rub the limbs with

[1] Sestier, *De la Foudre*, Paris, 1866. Quoted by Brouardel in his lectures upon "Death and Sudden Death."

[2] Benham's translation of Brouardel's lectures upon "Death and Sudden Death."

mustard, put a mustard plaster over the heart and another to the back of the neck, wrap the individual in hot blankets, and give enemata of hot saline fluid. In some cases venesection has seemed to be of benefit. When the individual reacts treat any existing condition symptomatically, and treat particular physical injuries according to their character.

Effects of Artificial Currents.—Workmen for electric companies; pedestrians in the streets of a city which is lighted by electricity or in which trolley cars are employed; roofers and firemen are liable to be injured by electricity. An alternating current is decidedly more dangerous than a continuous current of equal strength. An artificial current acts like lightning. It may produce instant death; it may produce unconsciousness, delirium, stertorous respiration, Cheyne-Stokes' breathing, or clonic spasms. Its effects can be often recovered from. Not unusually the victim is apparently dead, but subsequently recovers. D'Arsonval reports the case of a man who was apparently killed by the passage of 4500 volts. No attempt at resuscitation was made for one-half an hour, and yet he recovered when artificial respiration was employed. Donnellan reports a case of recovery after the passage of 1000 volts. Slight shocks may cause temporary numbness, and even motor paralysis. An electric shock frequently causes burns or ecchymoses, and occasionally wounds. Wounds caused by electricity bleed profusely and are apt to slough. An electric burn looks like a blackened crust; it is surrounded by pale skin, and for twenty-four hours remains dry, when inflammatory oozing begins and the skin around it reddens. These burns are not as painful as are ordinary burns, but recovery requires a long time. When inflammation begins and suppuration occurs, tissue is extensively destroyed, tendons, bones, and joints may suffer, some portions become deeply excavated, and other portions show dry adherent masses of dead and dying tissue, and a burn which was at first small may be followed by a large area of moist gangrene;[1] lack of tissue-resistance, due to trophic disturbance, is largely responsible for the progress of the sloughing.

Treatment.—If a person is in contact with a live wire, the first thing to do is, if possible, to shut off the current. If it is not possible to shut off the current, catch a portion of the clothing of the victim and pull him away from the wire, but do not touch his body with the bare hand. If a pair of

[1] See the article by N. W. Sharpe on "Peculiarities and Treatment of Electrical Injuries," in *Phila. Med. Jour.*, Jan. 29, 1898.

rubber gloves can be obtained, the subject can be moved with impunity and the wires can be safely cut. If it is not possible to drag a person away from electric wires, the surgeon can wrap his hands in dry cloth and lift the portion of the body in contact with earth or wire, and thus break the circuit and permit of removal of the body.[1] A dry cloth can be pushed between the body and the ground, and the body can then be removed from the wires. It may be possible to push the wires away by means of a dry piece of wood, or to cut them with shears which have wooden handles and which are perfectly dry. Treat the general condition in the manner set forth in the article on lightning-stroke (page 879). Very severe burns may be caused. The author has dressed a number of electric burns with hot fomentations of salt solution during the first few days. This facilitates the separation of the sloughs and seems to aid the weakened tissues in resisting microbic invasion; after sloughs separate, the part is dressed with dry sterile gauze. Antiseptic dressings can be used from the beginning, but they often fail entirely to arrest the sloughing. Iodoform produces much irritation. Ointments are very unsatisfactory. When the dressings are changed the part should not be washed with corrosive sublimate, as this agent produces much irritation; peroxid of hydrogen should be employed, followed by hot normal salt solution. Sharpe removes sloughs by applying the following mixture: 2 parts of scale pepsin, 1 part of hydrochloric acid, U.S.P.; 120 parts of distilled water. This mixture is washed off after two hours with peroxid of hydrogen. The same surgeon treats necrosis of bone by injecting every few hours a 3 per cent. solution of hydrochloric acid, using every second day the pepsin solution, and when necrotic areas come away packing with gauze. Skin-grafting by Reverdin's method or Thiersch's method is rarely successful. In some regions it is possible to slide a large flap in place to cover a granulating area which will not heal. In a very severe case amputation or resection may be necessary.

[1] See the directions in *Med. Record*, Dec. 28, 1895, from *Med. Press*.

INDEX.

Catalogue of the Medical Publications

OF

W. B. SAUNDERS & COMPANY

PHILADELPHIA — LONDON, W. C.
925 Walnut Street — 161 Strand

Arranged Alphabetically and Classified under Subjects

See page 20 for a List of Contents classified according to subjects

THE books advertised in this Catalogue as being *sold by subscription* are usually to be obtained from travelling solicitors, but they will be sent direct from the office of publication (charges of shipment prepaid) upon receipt of the prices given. All the other books advertised are commonly for sale by booksellers in all parts of the United States; but books will be sent to any address, carriage prepaid, on receipt of the published price.

Money may be sent at the risk of the publisher in either of the following ways: A postal money order, an express money order, a bank check, and in a registered letter. Money sent in any other way is at the risk of the sender.

SPECIAL OFFER To physicians of approved credit books will be sent, post-paid, on the following terms: $5.00 cash upon delivery of books, and monthly payments of $5.00 thereafter until full amount is paid. Any one or two volumes will be sent on thirty days' time to those who do not care to make a large purchase.

An American Text-Book *of* Applied Therapeutics.

Edited by JAMES C. WILSON, M. D., Professor of Practice of Medicine and of Clinical Medicine, Jefferson Medical College, Philadelphia. Handsome imperial octavo volume of 1326 pages. Illustrated. Cloth, $7.00 net; Sheep or Half Morocco, $8.00 net. *Sold by Subscription.*

An American Text-Book *of the* Diseases *of* Children.

Second Edition, Revised.

Edited by LOUIS STARR, M. D., Consulting Pediatrist to the Maternity Hospital, etc.; assisted by THOMPSON S. WESTCOTT, M. D., Attending Physician to the Dispensary for Diseases of Children, Hospital of the University of Pennsylvania. Handsome imperial octavo volume of 1244 pages, profusely illustrated. Cloth, $7.00 net; Sheep or Half Morocco, $8.00 net. *Sold by Subscription.*

An American Text-Book *of* Diseases *of the* Eye, Ear, Nose, *and* Throat.

Edited by G. E. DE SCHWEINITZ, M. D., Professor of Ophthalmology, Jefferson Medical College, Philadelphia; and B. ALEXANDER RANDALL, M. D., Clinical Professor of Diseases of the Ear, University of Pennsylvania. Imperial octavo of 1251 pages; 766 illustrations, 59 of them in colors. Cloth, $7.00 net; Sheep or Half Morocco, $8.00 net. *Sold by Subscription.*

An American Text-Book *of* Genito-Urinary *and* Skin Diseases.

Edited by L. BOLTON BANGS, M. D., Professor of Genito-Urinary Surgery, University and Bellevue Hospital Medical College, New York; and W. A. HARDAWAY, M. D., Professor of Diseases of the Skin, Missouri Medical College. Imperial octavo volume of 1229 pages, with 300 engravings and 20 full-page colored plates. Cloth, $7.00 net; Sheep or Half Morocco, $8.00 net. *Sold by Subscription.*

An American Text-Book *of* Gynecology, Medical *and* Surgical. Second Edition, Revised.

Edited by J. M. BALDY, M. D., Professor of Gynecology, Philadelphia Polyclinic, etc. Handsome imperial octavo volume of 718 pages; 341 illustrations in the text, and 38 colored and half-tone plates. Cloth, $6.00 net; Sheep or Half Morocco, $7.00 net. *Sold by Subscription.*

An American Text-Book *of* Legal Medicine *and* Toxicology.

Edited by FREDERICK PETERSON, M. D., Chief of Clinic, Nervous Department, College of Physicians and Surgeons, New York; and WALTER S. HAINES, M. D., Professor of Chemistry, Pharmacy, and Toxicology, Rush Medical College, Chicago. *In Preparation.*

An American Text-Book *of* Obstetrics.

Edited by RICHARD C. NORRIS, M. D.; Art Editor, ROBERT L. DICKINSON, M. D. Handsome imperial octavo volume of 1014 pages; nearly 900 beautiful colored and half-tone illustrations. Cloth, $7.00 net; Sheep or Half Morocco, $8.00 net. *Sold by Subscription.*

An American Text-Book *of* Pathology.

Edited by LUDWIG HEKTOEN, M. D., Professor of Pathology in Rush Medical College, Chicago; and DAVID RIESMAN, M. D., Demonstrator of Pathologic Histology in the University of Pennsylvania. Handsome imperial octavo, over 1200 pages, profusely illustrated. *By Subscription.*

An American Text-Book *of* Physiology. Second Edition, Revised, in Two Volumes.

Edited by WILLIAM H. HOWELL, PH. D., M. D., Professor of Physiology, Johns Hopkins University, Baltimore, Md. Two royal octavo volumes of about 600 pages each. Fully illustrated. Per volume: Cloth, $3.00 net; Sheep or Half Morocco, $3.75 net.

An American Text-Book *of* Surgery. Third Edition.

Edited by WILLIAM W. KEEN, M. D., LL. D., F. R. C. S. (Hon.); and J. WILLIAM WHITE, M. D., PH. D. Handsome octavo volume of 1230 pages; 496 wood-cuts and 37 colored and half-tone plates. Thoroughly revised and enlarged, with a section devoted to "The Use of the Röntgen Rays in Surgery." Cloth, $7.00 net; Sheep or Half Morocco, $8.00 net.

THE NEW STANDARD **THE NEW STANDARD**

The American Illustrated Medical Dictionary.

Second Edition, Revised.

For Practitioners and Students. A Complete Dictionary of the Terms used in Medicine, Surgery, Dentistry, Pharmacy, Chemistry, and the kindred branches, including much collateral information of an encyclopedic character, together with new and elaborate tables of Arteries, Muscles, Nerves, Veins, etc.; of Bacilli, Bacteria, Micrococci, Streptococci; Eponymic Tables of Diseases, Operations, Signs and Symptoms, Stains, Tests, Methods of Treatment, etc., etc. By W. A. NEWMAN DORLAND, A. M., M. D., Editor of the "American Pocket Medical Dictionary." Handsome large octavo, nearly 800 pages, bound in full flexible leather. Price, $4.50 net; with thumb index, $5.00 net.

Gives a Maximum Amount of Matter in a Minimum Space and at the Lowest Possible Cost.

This Edition contains all the Latest Words.

"I must acknowledge my astonishment at seeing how much he has condensed within relatively small space. I find nothing to criticise, very much to commend, and was interested in finding some of the new words which are not in other recent dictionaries."—ROSWELL PARK, *Professor of Principles and Practice of Surgery and Clinical Surgery, University of Buffalo.*

"I congratulate you upon giving to the profession a dictionary so compact in its structure, and so replete with information required by the busy practitioner and student. It is a necessity as well as an informed companion to every doctor. It should be upon the desk of every practitioner and student of medicine."—JOHN B. MURPHY, *Professor of Surgery and Clinical Surgery, Northwestern University Medical School,* Chicago.

The American Pocket Medical Dictionary. **Third Edition, Revised.**

Edited by W. A. NEWMAN DORLAND, M. D., Assistant Obstetrician to the Hospital of the University of Pennsylvania; Fellow of the American Academy of Medicine. Containing the pronunciation and definition of the principal words used in medicine and kindred sciences, with 64 extensive tables. Handsomely bound in flexible leather, with gold edges. Price $1.00 net; with thumb index, $1.25 net.

The American Year-Book *of* Medicine *and* Surgery.

A Yearly Digest of Scientific Progress and Authoritative Opinion in all branches of Medicine and Surgery, drawn from journals, monographs, and text-books of the leading American and Foreign authors and investigators. Arranged with critical editorial comments, by eminent American specialists, under the editorial charge of GEORGE M. GOULD, M. D. Year-Book of 1901 in two volumes—Vol. I. including *General Medicine;* Vol. II., *General Surgery.* Per volume: Cloth, $3.00 net; Half Morocco, $3.75 net. *Sold by Subscription.*

Abbott on Transmissible Diseases. **Second Edition, Revised.**

The Hygiene of Transmissible Diseases: their Causation, Modes of Dissemination, and Methods of Prevention. By A. C. ABBOTT, M. D., Professor of Hygiene and Bacteriology, University of Pennsylvania. Octavo, 351 pages, with numerous illustrations. Cloth, $2.50 net.

Anders' Practice of Medicine. Fifth Revised Edition.

A Text-Book of the Practice of Medicine. By JAMES M. ANDERS, M. D., PH. D., LL. D., Professor of the Practice of Medicine and of Clinical Medicine, Medico-Chirurgical College, Philadelphia. Handsome octavo volume of 1292 pages, fully illustrated. Cloth, $5.50 net; Sheep or Half Morocco, $6.50 net.

Bastin's Botany.

Laboratory Exercises in Botany. By EDSON S. BASTIN, M. A., late Professor of Materia Medica and Botany, Philadelphia College of Pharmacy. Octavo, 536 pages, with 87 plates. Cloth, $2.00 net.

Beck on Fractures.

Fractures. By CARL BECK, M. D., Surgeon to St. Mark's Hospital and the New York German Poliklinik, etc. With an appendix on the Practical Use of the Röntgen Rays. 335 pages, 170 illustrations. Cloth, $3.50 net.

Beck's Surgical Asepsis.

A Manual of Surgical Asepsis. By CARL BECK, M. D., Surgeon to St. Mark's Hospital and the New York German Poliklinik, etc. 306 pages; 65 text-illustrations and 12 full-page plates. Cloth, $1.25 net.

Boislinière's Obstetric Accidents, Emergencies, and Operations.

Obstetric Accidents, Emergencies, and Operations. By L. CH. BOISLINIÈRE, M. D., late Emeritus Professor of Obstetrics, St. Louis Medical College. 381 pages, handsomely illustrated. Cloth, $2.00 net.

Böhm, Davidoff, and Huber's Histology.

A Text-Book of Human Histology. Including Microscopic Technic. By DR. A. A. BÖHM and DR. M. VON DAVIDOFF, of Munich, and G. CARL HUBER, M. D., Junior Professor of Anatomy and Director of Histological Laboratory, University of Michigan. Handsome octavo of 503 pages, with 351 beautiful original illustrations. Cloth, $3.50 net.

Butler's Materia Medica, Therapeutics, and Pharmacology. Third Edition, Revised.

A Text-Book of Materia Medica, Therapeutics, and Pharmacology. By GEORGE F. BUTLER, PH. G., M. D., Professor of Materia Medica and of Clinical Medicine, College of Physicians and Surgeons, Chicago. Octavo, 874 pages, illustrated. Cloth, $4.00 net; Sheep or Half Morocco, $5.00 net.

Cerna on the Newer Remedies. Second Edition, Revised.

Notes on the Newer Remedies, their Therapeutic Applications and Modes of Administration. By DAVID CERNA, M. D., PH. D., Demonstrator of Physiology, Medical Department, University of Texas. Rewritten and greatly enlarged. Post-octavo, 253 pages. Cloth, $1.00 net.

Chapin on Insanity.

A Compendium of Insanity. By JOHN B. CHAPIN, M. D., LL. D., Physician-in-Chief, Pennsylvania Hospital for the Insane: Honorary Member of the Medico-Psychological Society of Great Britain, of the Society of Mental Medicine of Belgium, etc. 12mo, 234 pages, illustrated. Cloth, $1.25 net.

Chapman's Medical Jurisprudence *and* Toxicology.

Second Edition, Revised.

Medical Jurisprudence and Toxicology. By HENRY C. CHAPMAN, M. D., Professor of Institutes of Medicine and Medical Jurisprudence, Jefferson Medical College of Philadelphia. 254 pages, with 55 illustrations and 3 full-page plates in colors. Cloth, $1.50 net.

Church *and* Peterson's Nervous *and* Mental Diseases.

Third Edition, Revised and Enlarged.

Nervous and Mental Diseases. By ARCHIBALD CHURCH, M. D., Professor of Nervous and Mental Diseases, and Head of the Neurological Department, Northwestern University Medical School, Chicago; and FREDERICK PETERSON, M. D., Chief of Clinic, Nervous Department, College of Physicians and Surgeons, New York. Handsome octavo volume of 875 pages, profusely illustrated. Cloth, $5.00 net; Sheep or Half Morocco, $6.00 net.

Clarkson's Histology.

A Text-Book of Histology, Descriptive and Practical. By ARTHUR CLARKSON, M. B., C. M. Edin., formerly Demonstrator of Physiology in the Owen's College, Manchester; late Demonstrator of Physiology in Yorkshire College, Leeds. Large octavo, 554 pages; 22 engravings and 174 beautifully colored original illustrations. Cloth, $4.00 net.

Corwin's Physical Diagnosis. **Third Edition, Revised.**

Essentials of Physical Diagnosis of the Thorax. By ARTHUR M. CORWIN, A. M., M. D., Instructor in Physical Diagnosis in Rush Medical College, Chicago. 219 pages, illustrated. Cloth, $1.25 net.

Crookshank's Bacteriology. **Fourth Edition, Revised.**

A Text-Book of Bacteriology. By EDGAR M. CROOKSHANK, M. B., Professor of Comparative Pathology and Bacteriology, King's College, London. Octavo, 700 pages, 273 engravings and 22 original colored plates. Cloth, $6.50 net; Half Morocco, $7.50 net.

DaCosta's Surgery. **Third Edition, Revised.**

Modern Surgery, General and Operative. By JOHN CHALMERS DA COSTA, M. D., Professor of Principles of Surgery and Clinical Surgery, Jefferson Medical College, Philadelphia; Surgeon to the Philadelphia Hospital, etc. Handsome octavo volume of 1117 pages, profusely illustrated. Cloth, $5.00 net; Sheep or Half Morocco, $6.00 net.

Enlarged by over 200 Pages, with more than 100 New Illustrations.

Davis's Obstetric Nursing.

Obstetric and Gynecologic Nursing. By EDWARD P. DAVIS, A. M., M. D., Professor of Obstetrics in Jefferson Medical College and the Philadelphia Polyclinic; Obstetrician and Gynecologist to the Philadelphia Hospital. 12mo volume of 400 pages, fully illustrated. Crushed Buckram, $1.75 net.

DeSchweinitz on Diseases *of the* Eye. Third Edition, Revised.

Diseases of the Eye. A Handbook of Ophthalmic Practice. By G. E. DE SCHWEINITZ, M. D., Professor of Ophthalmology, Jefferson Medical College, Philadelphia, etc. Handsome royal octavo volume of 696 pages; 256 fine illustrations and 2 chromo-lithographic plates. Cloth, $4.00 net; Sheep or Half Morocco, $5.00 net.

Dorland's Dictionaries.

[See *American Illustrated Medical Dictionary* and *American Pocket Medical Dictionary* on page 3.]

Dorland's Obstetrics. Second Edition, Revised and Greatly Enlarged.

Modern Obstetrics. By W. A. NEWMAN DORLAND, M. D., Assistant Demonstrator of Obstetrics, University of Pennsylvania; Associate in Gynecology, Philadelphia Polyclinic. Octavo volume of 797 pages, with 201 illustrations. Cloth, $4.00 net.

Eichhorst's Practice *of* Medicine.

A Text-Book of the Practice of Medicine. By DR. HERMAN EICHHORST, Professor of Special Pathology and Therapeutics and Director of the Medical Clinic, University of Zurich. Translated and edited by AUGUSTUS A. ESHNER, M. D., Professor of Clinical Medicine, Philadelphia Polyclinic. Two octavo volumes of 600 pages each, over 150 illustrations. Prices per set: Cloth, $6.00 net; Sheep or Half Morocco, $7.50 net.

Friedrich *and* Curtis on *the* Nose, Throat, *and* Ear.

Rhinology, Laryngology, and Otology, and Their Significance in General Medicine. By DR. E. P. FRIEDRICH, of Leipzig. Edited by H. HOLBROOK CURTIS, M. D., Consulting Surgeon to the New York Nose and Throat Hospital. Octavo, 348 pages. Cloth, $2.50 net.

Frothingham's Guide for *the* Bacteriologist.

Laboratory Guide for the Bacteriologist. By LANGDON FROTHINGHAM, M. D. V., Assistant in Bacteriology and Veterinary Science, Sheffield Scientific School, Yale University. Illustrated. Cloth, 75 cts. net.

Garrigues' Diseases *of* Women. Third Edition, Revised.

Diseases of Women. By HENRY J. GARRIGUES, A. M., M. D., Gynecologist to St. Mark's Hospital and to the German Dispensary, New York City. Octavo, 756 pages, with 367 engravings and colored plates. Cloth, $4.50 net; Sheep or Half Morocco, $5.50 net.

Gould *and* Pyle's Curiosities *of* Medicine.

Anomalies and Curiosities of Medicine. By GEORGE M. GOULD, M. D., and WALTER L. PYLE, M. D. An encyclopedic collection of rare and extraordinary cases and of the most striking instances of abnormality in all branches of Medicine and Surgery, derived from an exhaustive research of medical literature from its origin to the present day, abstracted, classified, annotated, and indexed. Handsome octavo volume of 968 pages; 295 engravings and 12 full-page plates. Popular Edition. Cloth, $3.00 net; Sheep or Half Morocco, $4.00 net.

Grafstrom's Mechano-Therapy.

A Text-Book of Mechano-Therapy (Massage and Medical Gymnastics). By AXEL V. GRAFSTROM, B. Sc., M. D., late House Physician, City Hospital, Blackwell's Island, New York. 12mo, 139 pages, illustrated. Cloth, $1.00 net.

Griffith on *the* Baby. Second Edition, Revised.

The Care of the Baby. By J. P. CROZER GRIFFITH, M. D., Clinical Professor of Diseases of Children, University of Pennsylvania; Physician to the Children's Hospital, Philadelphia, etc. 12mo, 404 pages; 67 illustrations and 5 plates. Cloth, $1.50 net.

Griffith's Weight Chart.

Infant's Weight Chart. Designed by J. P. CROZER GRIFFITH, M. D., Clinical Professor of Diseases of Children, University of Pennsylvania. 25 charts in each pad. Per pad, 50 cts. net.

Hart's Diet in Sickness *and* in Health.

Diet in Sickness and Health. By MRS. ERNEST HART, formerly Student of the Faculty of Medicine of Paris and of the London School of Medicine for Women; with an Introduction by SIR HENRY THOMPSON, F. R. C. S., M. D., London. 220 pages. Cloth, $1.50 net.

Haynes' Anatomy.

A Manual of Anatomy. By IRVING S. HAYNES, M. D., Professor of Practical Anatomy in Cornell University Medical College. 680 pages; 42 diagrams and 134 full-page half-tone illustrations from original photographs of the author's dissections. Cloth, $2.50 net.

Heisler's Embryology. Second Edition, Revised,

A Text-Book of Embryology. By JOHN C. HEISLER, M. D., Professor of Anatomy, Medico-Chirurgical College, Philadelphia. Octavo volume of 405 pages, handsomely illustrated. Cloth, $2.50 net.

Hirst's Obstetrics. Third Edition, Revised and Enlarged.

A Text-Book of Obstetrics. By BARTON COOKE HIRST, M. D., Professor of Obstetrics, University of Pennsylvania. Handsome octavo volume of 873 pages; 704 illustrations, 36 of them in colors. Cloth, $5.00 net; Sheep or Half Morocco, $6.00 net.

Hyde *and* Montgomery on Syphilis *and the* Venereal Diseases. **Second Edition, Revised and Greatly Enlarged.**

Syphilis and the Venereal Diseases. By JAMES NEVINS HYDE, M. D., Professor of Skin and Venereal Diseases, and FRANK H. MONTGOMERY, M. D., Associate Professor of Skin, Genito-Urinary, and Venereal Diseases in Rush Medical College, Chicago, Ill. Octavo, 594 pages, profusely illustrated. Cloth, $4.00 net.

The International Text-Book of Surgery. **In Two Volumes.**

By American and British Authors. Edited by J. COLLINS WARREN, M. D., LL. D., F. R. C. S. (Hon.), Professor of Surgery, Harvard Medical School, Boston; and A. PEARCE GOULD, M. S., F. R. C. S., Lecturer on Practical Surgery and Teacher of Operative Surgery, Middlesex Hospital Medical School, London, Eng. Vol. I. *General Surgery.*—Handsome octavo, 947 pages, with 458 beautiful illustrations and 9 lithographic plates. Vol. II. *Special or Regional Surgery.*—Handsome octavo, 1072 pages, with 471 beautiful illustrations and 8 lithographic plates. *Sold by Subscription.* Prices per volume: Cloth, $5.00 net; Sheep or Half Morocco, $6.00 net.

"It is the most valuable work on the subject that has appeared in some years. The clinician and the pathologist have joined hands in its production, and the result must be a satisfaction to the editors as it is a gratification to the conscientious reader."—*Annals of Surgery.*

"This is a work which comes to us on its own intrinsic merits. Of the latter it has very many. The arrangement of subjects is excellent, and their treatment by the different authors is equally so. What is especially to be recommended is the painstaking endeavor of each writer to make his subject clear and to the point. To this end particularly is the technique of operations lucidly described in all necessary detail. And withal the work is up to date in a very remarkable degree, many of the latest operations in the different regional parts of the body being given in full details. There is not a chapter in the work from which the reader may not learn something new."—*Medical Record,* New York.

Jackson's Diseases *of the* Eye.

A Manual of Diseases of the Eye. By EDWARD JACKSON, A. M., M. D., Emeritus Professor of Diseases of the Eye, Philadelphia Polyclinic and College for Graduates in Medicine. 12mo volume of 535 pages, with 178 illustrations, mostly from drawings by the author. Cloth, $2.50 net.

Keating's Life Insurance.

How to Examine for Life Insurance. By JOHN M. KEATING, M. D., Fellow of the College of Physicians of Philadelphia; Ex-President of the Association of Life Insurance Medical Directors. Royal octavo, 211 pages. With numerous illustrations. Cloth, $2.00 net.

Keen on *the* Surgery *of* Typhoid Fever.

The Surgical Complications and Sequels of Typhoid Fever. By WM. W. KEEN, M. D., LL. D., F. R. C. S. (Hon.), Professor of the Principles of Surgery and of Clinical Surgery, Jefferson Medical College, Philadelphia, etc. Octavo volume of 386 pages, illustrated. Cloth, $3.00 net.

Keen's Operation Blank. **Second Edition, Revised Form.**

An Operation Blank, with Lists of Instruments, etc., Required in Various Operations. Prepared by W. W. KEEN, M. D., LL. D., F. R. C. S. (Hon.), Professor of the Principles of Surgery and of Clinical Surgery, Jefferson Medical College, Philadelphia. Price per pad, blanks for fifty operations, 50 cts. net.

Kyle on *the* Nose and Throat. **Second Edition.**

Diseases of the Nose and Throat. By D. BRADEN KYLE, M. D., Clinical Professor of Laryngology and Rhinology, Jefferson Medical College, Philadelphia. Octavo, 646 pages; over 150 illustrations and 6 lithographic plates. Cloth, $4.00 net; Sheep or Half Morocco, $5.00 net.

Lainé's Temperature Chart.

Temperature Chart. Prepared by D. T. LAINÉ, M. D. Size 8 x 13½ inches. A conveniently arranged Chart for recording Temperature, with columns for daily amounts of Urinary and Fecal Excretions, Food, Remarks, etc. On the back of each chart is given the Brand treatment of Typhoid Fever. Price, per pad of 25 charts, 50 cts. net.

Levy, Klemperer, *and* Eshner's Clinical Bacteriology.

The Elements of Clinical Bacteriology. By DR. ERNST LEVY, Professor in the University of Strasburg, and FELIX KLEMPERER, Privatdocent in the University of Strasburg. Translated and edited by AUGUSTUS A. ESHNER, M. D., Professor of Clinical Medicine, Philadelphia Polyclinic. Octavo, 440 pages, fully illustrated. Cloth, $2.50 net.

Lockwood's Practice *of* Medicine. **Second Edition, Revised and Enlarged.**

A Manual of the Practice of Medicine. By GEORGE ROE LOCKWOOD, M. D., Professor of Practice in the Woman's Medical College of the New York Infirmary, etc.

Long's Syllabus *of* Gynecology.

A Syllabus of Gynecology, arranged in Conformity with "An American Text-Book of Gynecology." By J. W. LONG, M. D., Professor of Diseases of Women and Children, Medical College of Virginia, etc. Cloth, interleaved, $1.00 net.

Macdonald's Surgical Diagnosis *and* Treatment.

Surgical Diagnosis and Treatment. By J. W. MACDONALD, M. D. Edin., F. R. C. S. Edin., Professor of Practice of Surgery and Clinical Surgery, Hamline University. Handsome octavo, 800 pages, fully illustrated. Cloth, $5.00 net; Sheep or Half Morocco, $6.00 net.

Mallory *and* Wright's Pathological Technique.

Second Edition, Revised.

Pathological Technique. A Practical Manual for Laboratory Work in Pathology, Bacteriology, and Morbid Anatomy, with chapters on Post-Mortem Technique and the Performance of Autopsies. By FRANK B. MALLORY, A. M., M. D., Assistant Professor of Pathology, Harvard University Medical School, Boston; and JAMES H. WRIGHT, A. M., M. D., Instructor in Pathology, Harvard University Medical School, Boston.

McFarland's Pathogenic Bacteria. **Third Edition, increased in size by over 100 Pages.**

Text-Book upon the Pathogenic Bacteria. By JOSEPH MCFARLAND, M. D., Professor of Pathology and Bacteriology, Medico-Chirurgical College of Philadelphia, etc. Octavo volume of 621 pages, finely illustrated. Cloth, $3.25 net.

Meigs on Feeding in Infancy.

Feeding in Early Infancy. By ARTHUR V. MEIGS, M. D. Bound in limp cloth, flush edges, 25 cts. net.

Moore's Orthopedic Surgery.

A Manual of Orthopedic Surgery. By JAMES E. MOORE, M. D., Professor of Orthopedics and Adjunct Professor of Clinical Surgery, University of Minnesota, College of Medicine and Surgery. Octavo volume of 356 pages, handsomely illustrated. Cloth, $2.50 net.

Morten's Nurses' Dictionary.

Nurses' Dictionary of Medical Terms and Nursing Treatment. Containing Definitions of the Principal Medical and Nursing Terms and Abbreviations; of the Instruments, Drugs, Diseases, Accidents, Treatments, Operations, Foods, Appliances, etc. encountered in the ward or in the sick-room. By HONNOR MORTEN, author of "How to Become a Nurse," etc. 16mo, 140 pages. Cloth, $1.00 net.

Nancrede's Anatomy *and* Dissection. Fourth Edition.

Essentials of Anatomy and Manual of Practical Dissection. By CHARLES B. NANCREDE, M. D., LL. D., Professor of Surgery and of Clinical Surgery, University of Michigan, Ann Arbor. Post-octavo, 500 pages, with full-page lithographic plates in colors and nearly 200 illustrations. Extra Cloth (or Oilcloth for dissection-room), $2.00 net.

Nancrede's Principles *of* Surgery.

Lectures on the Principles of Surgery. By CHAS. B. NANCREDE, M. D., LL. D., Professor of Surgery and of Clinical Surgery, University of Michigan, Ann Arbor. Octavo, 398 pages, illustrated. Cloth, $2.50 net.

Norris's Syllabus *of* Obstetrics. Third Edition, Revised.

Syllabus of Obstetrical Lectures in the Medical Department of the University of Pennsylvania. By RICHARD C. NORRIS, A. M., M. D., Instructor in Obstetrics and Lecturer on Clinical and Operative Obstetrics, University of Pennsylvania. Crown octavo, 222 pages. Cloth, interleaved for notes, $2.00 net.

Ogden on *the* Urine.

Clinical Examination of the Urine and Urinary Diagnosis. A Clinical Guide for the Use of Practitioners and Students of Medicine and Surgery. By J. BERGEN OGDEN, M. D., Instructor in Chemistry, Harvard Medical School. Handsome octavo, 416 pages, with 54 illustrations and a number of colored plates. Cloth, $3.00 net.

Penrose's Diseases *of* Women. Fourth Edition, Revised.

A Text-Book of Diseases of Women. By CHARLES B. PENROSE, M. D., PH. D., formerly Professor of Gynecology in the University of Pennsylvania. Octavo volume of 538 pages, handsomely illustrated. Cloth, $3.75 net.

Pryor—Pelvic Inflammations.

The Treatment of Pelvic Inflammations through the Vagina. By W. R. Pryor, M. D., Professor of Gynecology, New York Polyclinic. 12mo, 248 pages, handsomely illustrated. Cloth, $2.00 net.

Pye's Bandaging.

Elementary Bandaging and Surgical Dressing. With Directions concerning the Immediate Treatment of Cases of Emergency. By Walter Pye, F. R. C. S., late Surgeon to St. Mary's Hospital, London. Small 12mo, over 80 illustrations. Cloth, flexible covers, 75 cts. net.

Pyle's Personal Hygiene.

A Manual of Personal Hygiene. Proper Living upon a Physiologic Basis. Edited by Walter L. Pyle, M. D., Assistant Surgeon to the Wills Eye Hospital, Philadelphia. Octavo volume of 344 pages, fully illustrated. Cloth, $1.50 net.

Raymond's Physiology. Second Edition, Revised and Greatly Enlarged.

A Text-Book of Physiology. By Joseph H. Raymond, A. M., M. D., Professor of Physiology and Hygiene and Lecturer on Gynecology in the Long Island College Hospital.

Salinger *and* Kalteyer's Modern Medicine.

Modern Medicine. By Julius L. Salinger, M. D., Demonstrator of Clinical Medicine, Jefferson Medical College; and F. J. Kalteyer, M. D., Assistant Demonstrator of Clinical Medicine, Jefferson Medical College. Handsome octavo, 801 pages, illustrated. Cloth, $4.00 net.

Saundby's Renal *and* Urinary Diseases.

Lectures on Renal and Urinary Diseases. By Robert Saundby, M. D. Edin., Fellow of the Royal College of Physicians, London, and of the Royal Medico-Chirurgical Society; Professor of Medicine in Mason College, Birmingham, etc. Octavo, 434 pages, with numerous illustrations and 4 colored plates. Cloth, $2.50 net.

Saunders' Medical Hand-Atlases.

See pages 16 and 17.

Saunders' Pocket Medical Formulary. Sixth Edition, Revised.

By William M. Powell, M. D., author of "Essentials of Diseases of Children"; Member of Philadelphia Pathological Society. Containing 1844 formulæ from the best-known authorities. With an Appendix containing Posological Table, Formulæ and Doses for Hypodermic Medication, Poisons and their Antidotes, Diameters of the Female Pelvis and Fetal Head, Obstetrical Table, Diet List for Various Diseases, Materials and Drugs used in Antiseptic Surgery, Treatment of Asphyxia from Drowning, Surgical Remembrancer, Tables of Incompatibles, Eruptive Fevers, etc., etc. Handsomely bound in flexible morocco, with side index, wallet, and flap. $2.00 net.

Saunders' Question-Compends.

See page 15.

Scudder's Fractures. **Second Edition, Revised.**

The Treatment of Fractures. By CHAS. L. SCUDDER, M. D., Assistant in Clinical and Operative Surgery, Harvard University Medical School. Octavo, 460 pages, with nearly 600 original illustrations. Polished Buckram, $4.50 net; Half Morocco, $5.50 net.

Senn's Genito-Urinary Tuberculosis.

Tuberculosis of the Genito-Urinary Organs, Male and Female. By NICHOLAS SENN, M. D., PH. D., LL. D., Professor of the Practice of Surgery and of Clinical Surgery, Rush Medical College, Chicago. Handsome octavo volume of 320 pages, illustrated. Cloth, $3.00 net.

Senn's Practical Surgery.

Practical Surgery. By NICHOLAS SENN, M. D., PH. D., LL. D., Professor of the Practice of Surgery and of Clinical Surgery, Rush Medical College, Chicago. Handsome octavo volume of 1200 pages, profusely illustrated. Cloth, $6.00 net; Sheep or Half Morocco, $7.00 net. *By Subscription.*

Senn's Syllabus *of* Surgery.

A Syllabus of Lectures on the Practice of Surgery, arranged in conformity with "An American Text-Book of Surgery." By NICHOLAS SENN, M. D., PH. D., LL. D., Professor of the Practice of Surgery and of Clinical Surgery, Rush Medical College, Chicago. Cloth, $1.50 net.

Senn's Tumors. **Second Edition, Revised.**

Pathology and Surgical Treatment of Tumors. By NICHOLAS SENN, M. D., PH. D., LL. D., Professor of the Practice of Surgery and of Clinical Surgery, Rush Medical College, Chicago. Octavo volume of 718 pages, with 478 illustrations, including 12 full-page plates in colors. Cloth, $5.00 net; Sheep or Half Morocco, $6.00 net.

Starr's Diets for Infants *and* Children.

Diets for Infants and Children in Health and in Disease. By LOUIS STARR, M. D., Editor of "An American Text-Book of the Diseases of Children." 230 blanks (pocket-book size), perforated and neatly bound in flexible morocco. $1.25 net.

Stengel's Pathology. **Third Edition, Thoroughly Revised.**

A Text-Book of Pathology. By ALFRED STENGEL, M. D., Professor of Clinical Medicine, University of Pennsylvania; Visiting Physician to the Pennsylvania Hospital. Handsome octavo, 873 pages, nearly 400 illustrations, many of them in colors. Cloth, $5.00 net; Sheep or Half Morocco, $6.00 net.

Stengel *and* White on *the* Blood.

The Blood in its Clinical and Pathological Relations. By ALFRED STENGEL, M. D., Professor of Clinical Medicine, University of Pennsylvania; and C. Y. WHITE, JR., M. D., Instructor in Clinical Medicine, University of Pennsylvania. *In Press.*

Stevens' Therapeutics. **Third Edition, Revised and Greatly Enlarged.**

A Text-Book of Modern Therapeutics. By A. A. STEVENS, A. M., M. D., Lecturer on Physical Diagnosis in the University of Pennsylvania.

Stevens' Practice *of* Medicine. **Fifth Edition, Revised.**

A Manual of the Practice of Medicine. By A. A. STEVENS, A. M., M. D., Lecturer on Physical Diagnosis in the University of Pennsylvania. Specially intended for students preparing for graduation and hospital examinations. Post-octavo, 519 pages; illustrated. Flexible Leather, $2.00 net.

Stewart's Physiology. **Fourth Edition, Revised.**

A Manual of Physiology, with Practical Exercises. For Students and Practitioners. By G. N. STEWART, M. A., M. D., D. Sc., Professor of Physiology in the Western Reserve University, Cleveland, Ohio. Octavo volume of 894 pages; 336 illustrations and 5 colored plates. Cloth, $3.75 net.

Stoney's Materia Medica for Nurses.

Materia Medica for Nurses. By EMILY A. M. STONEY, late Superintendent of the Training-School for Nurses, Carney Hospital, South Boston, Mass. Handsome octavo volume of 306 pages. Cloth, $1.50 net.

Stoney's Nursing. **Second Edition, Revised.**

Practical Points in Nursing. For Nurses in Private Practice. By EMILY A. M. STONEY, late Superintendent of the Training-School for Nurses, Carney Hospital, South Boston, Mass. 456 pages, with 73 engravings and 8 colored and half-tone plates. Cloth, $1.75 net.

Stoney's Surgical Technic for Nurses.

Bacteriology and Surgical Technic for Nurses. By EMILY A. M. STONEY, late Superintendent of the Training-School for Nurses, Carney Hospital, South Boston, Mass. 12mo volume, fully illustrated. Cloth, $1.25 net.

Thomas's Diet Lists. **Second Edition, Revised.**

Diet Lists and Sick-Room Dietary. By JEROME B. THOMAS, M. D., Visiting Physician to the Home for Friendless Women and Children and to the Newsboys' Home; Assistant Visiting Physician to the Kings County Hospital. Cloth, $1.25 net. Send for sample sheet.

Thornton's Dose-Book *and* Prescription-Writing.
Second Edition, Revised and Enlarged.

Dose-Book and Manual of Prescription-Writing. By E. Q. THORNTON, M. D., Demonstrator of Therapeutics, Jefferson Medical College, Philadelphia.

Van Valzah *and* Nisbet's Diseases *of the* Stomach.

Diseases of the Stomach. By WILLIAM W. VAN VALZAH, M. D., Professor of General Medicine and Diseases of the Digestive System and the Blood, New York Polyclinic; and J. DOUGLAS NISBET, M. D., Adjunct Professor of General Medicine and Diseases of the Digestive System and the Blood, New York Polyclinic. Octavo volume of 674 pages, illustrated. Cloth, $3.50 net.

Vecki's Sexual Impotence. Second Edition, Revised.

The Pathology and Treatment of Sexual Impotence. By VICTOR G. VECKI, M. D. From the second German edition, revised and enlarged. Demi-octavo, 291 pages. Cloth, $2.00 net.

Vierordt's Medical Diagnosis. Fourth Edition, Revised.

Medical Diagnosis. By DR. OSWALD VIERORDT, Professor of Medicine, University of Heidelberg. Translated, with additions, from the fifth enlarged German edition, with the author's permission, by FRANCIS H. STUART, A. M., M. D. Handsome octavo volume, 603 pages; 194 wood-cuts, many of them in colors. Cloth, $4.00 net; Sheep or Half Morocco, $5.00 net.

Watson's Handbook for Nurses.

A Handbook for Nurses. By J. K. WATSON, M. D. Edin. American Edition, under supervision of A. A. STEVENS, A. M., M. D., Lecturer on Physical Diagnosis, University of Pennsylvania. 12mo, 413 pages, 73 illustrations. Cloth, $1.50 net.

Warren's Surgical Pathology. Second Edition.

Surgical Pathology and Therapeutics. By JOHN COLLINS WARREN, M. D., LL. D., F. R. C. S. (Hon.), Professor of Surgery, Harvard Medical School. Handsome octavo, 873 pages; 136 relief and lithographic illustrations, 33 in colors. With an Appendix on Scientific Aids to Surgical Diagnosis, and a series of articles on Regional Bacteriology. Cloth, $5.00 net; Sheep or Half Morocco, $6.00 net.

SAUNDERS'

QUESTION-COMPENDS.

ARRANGED IN QUESTION AND ANSWER FORM.

The Most Complete and Best Illustrated Series of Compends Ever Issued.

NOW THE STANDARD AUTHORITIES IN MEDICAL LITERATURE

WITH

Students and Practitioners in every City of the United States and Canada.

Since the issue of the first volume of the Saunders Question-Compends,

OVER 200,000 COPIES

of these unrivalled publications have been sold. This enormous sale is indisputable evidence of the value of these self-helps to students and physicians.

SEE NEXT PAGE FOR LIST.

Saunders' Medical Hand-Atlases.

VOLUMES NOW READY.

Atlas and Epitome of Internal Medicine and Clinical Diagnosis.

By Dr. Chr. Jakob, of Erlangen. Edited by Augustus A. Eshner, M. D., Professor of Clinical Medicine, Philadelphia Polyclinic. With 179 colored figures on 68 plates, 64 text-illustrations, 259 pages of text. Cloth, $3.00 net.

Atlas of Legal Medicine.

By Dr. E. R. von Hofmann, of Vienna. Edited by Frederick Peterson, M. D., Chief of Clinic, Nervous Department, College of Physicians and Surgeons, New York. With 120 colored figures on 56 plates and 193 beautiful half-tone illustrations. Cloth, $3.50 net.

Atlas and Epitome of Diseases of the Larynx.

By Dr. L. Grunwald, of Munich. Edited by Charles P. Grayson, M. D., Physician-in-Charge, Throat and Nose Department, Hospital of the University of Pennsylvania. With 107 colored figures on 44 plates, 25 text-illustrations, and 103 pages of text. Cloth, $2.50 net.

Atlas and Epitome of Operative Surgery.

By Dr. O. Zuckerkandl, of Vienna. Edited by J. Chalmers DaCosta, M. D., Professor of Principles of Surgery and Clinical Surgery, Jefferson Medical College, Philadelphia. With 24 colored plates, 217 text-illustrations, and 395 pages of text. Cloth, $3.00 net.

Atlas and Epitome of Syphilis and the Venereal Diseases.

By Prof. Dr. Franz Mracek, of Vienna. Edited by L. Bolton Bangs, M. D., Professor of Genito-Urinary Surgery, University and Bellevue Hospital Medical College, New York. With 71 colored plates, 16 illustrations, and 122 pages of text. Cloth, $3.50 net.

Atlas and Epitome of External Diseases of the Eye.

By Dr. O. Haab, of Zurich. Edited by G. E. de Schweinitz, M. D., Professor of Ophthalmology, Jefferson Medical College, Philadelphia. With 76 colored illustrations on 40 plates and 228 pages of text. Cloth, $3.00 net.

Atlas and Epitome of Skin Diseases.

By Prof. Dr. Franz Mracek, of Vienna. Edited by Henry W. Stelwagon, M. D., Clinical Professor of Dermatology, Jefferson Medical College, Philadelphia. With 63 colored plates, 39 half-tone illustrations, and 200 pages of text. Cloth, $3.50 net.

Atlas and Epitome of Special Pathological Histology.

By Dr. H. Durck, of Munich. Edited by Ludwig Hektoen M. D., Professor of Pathology, Rush Medical College, Chicago. In Two Parts. Part I. *Ready*, including Circulatory, Respiratory, and Gastro-intestinal Tract, 120 colored figures on 62 plates, 158 pages of text. Part II. *Ready Shortly*. Price of Part I., $3.00 net.

NOTHNAGEL'S ENCYCLOPEDIA

OF

PRACTICAL MEDICINE

Edited by ALFRED STENGEL, M. D.

Professor of Clinical Medicine in the University of Pennsylvania; Visiting Physician to the Pennsylvania Hospital

IT is universally acknowledged that the Germans lead the world in Internal Medicine; and of all the German works on this subject, Nothnagel's "Encyclopedia of Special Pathology and Therapeutics" is conceded by scholars to be without question the **best System of Medicine in existence.** So necessary is this book in the study of Internal Medicine that it comes largely to this country in the original German. In view of these facts, Messrs. W. B. Saunders & Company have arranged with the publishers to issue at once **an authorized edition** of this great encyclopedia of medicine in English.

For the present a set of some ten or twelve volumes, representing the most practical part of this encyclopedia, and selected with especial thought of the **needs of the practical physician,** will be published. The volumes will contain the real essence of the entire work, and the purchaser will therefore obtain at less than half the cost the cream of the original. Later the special and more strictly scientific volumes will be offered from time to time.

The work will be translated by men possessing thorough knowledge of both English and German, and **each volume** will be **edited by a prominent specialist** on the subject to which it is devoted. It will thus be brought thoroughly up to date, and the American edition will be more than a mere translation of the German; for, in addition to the matter contained in the original, it will represent the **very latest views of the leading American specialists** in the various departments of Internal Medicine. The whole System will be under the editorial supervision of **Dr. Alfred Stengel,** who will select the subjects for the American edition, and will choose the editors of the different volumes.

Unlike most encyclopedias, the publication of this work **will not be extended over a number of years,** but five or six volumes will be issued during the coming year, and the remainder of the series at the same rate. Moreover, each volume will be revised to the date of its publicatfon by the American editor. This will obviate the objection that has heretofore existed to systems published in a number of volumes, since the subscriber will receive the completed work while the earlier volumes are still fresh.

The usual method of publishers, when issuing a work of this kind, has been to compel physicians to take the entire System. This seems to us in many cases to be undesirable. Therefore, in purchasing this encyclopedia, physicians will be given the opportunity of subscribing for the entire System at one time; but any single volume or any number of volumes may be obtained by those who do not desire the complete series. This latter method, while not so profitable to the publisher, **offers to the purchaser many advantages** which will be appreciated by those who do not care to subscribe for the entire work at one time.

This American edition of Nothnagel's Encyclopedia will, without question, form **the greatest System of Medicine ever produced,** and the publishers feel confident that it will meet with general favor in the medical profession.

NOTHNAGEL'S ENCYCLOPEDIA

VOLUMES JUST ISSUED AND IN PRESS

VOLUME I

Editor, William Osler, M.D., F.R.C.P.

Professor of Medicine in Johns Hopkins University

CONTENTS

Typhoid Fever. By DR. H. CURSCHMANN, of Leipsic. **Typhus Fever.** By DR. H. CURSCHMANN, of Leipsic.

Handsome octavo volume of about 600 pages.
Just Issued

VOLUME II

Editor, Sir J. W. Moore, B.A., M.D., F.R.C.P.I., of Dublin

Professor of Practice of Medicine, Royal College of Surgeons in Ireland

CONTENTS

Erysipelas and Erysipeloid. By DR. H. LENHARTZ, of Hamburg. **Cholera Asiatica and Cholera Nostras.** By DR. K. VON LIEBERMEISTER, of Tübingen. **Whooping Cough and Hay Fever.** By DR. G. STICKER, of Giessen. **Varicella.** By DR. TH. VON JÜRGENSEN, of Tübingen. **Variola (including Vaccination).** By DR. H. IMMERMANN, of Basle.

Handsome octavo volume of over 700 pages.
Just Issued

VOLUME III

Editor, William P. Northrup, M.D.

Professor of Pediatrics, University and Bellevue Medical College

CONTENTS

Measles. By DR. TH. VON JÜRGENSEN, of Tübingen. **Scarlet Fever.** By the same author. **Rotheln.** By the same author.

VOLUME VI

Editor, Alfred Stengel, M.D.

Professor of Clinical Medicine, University of Pennsylvania

CONTENTS

Anemia. By DR. P. EHRLICH, of Frankfort-on-the-Main, and DR. A. LAZARUS, of Charlottenburg. **Chlorosis.** By DR. K. VON NOORDEN, of Frankfort-on-the-Main. **Diseases of the Spleen and Hemorrhagic Diathesis.** By DR. M. LITTEN, of Berlin.

VOLUME VII

Editor, John H. Musser, M.D.

Professor of Clinical Medicine, University of Pennsylvania

CONTENTS

Diseases of the Bronchi. By DR. F. A. HOFFMANN, of Leipsic. **Diseases of the Pleura.** By DR. ROSENBACH, of Berlin. **Pneumonia.** By DR. E. AUFRECHT, of Magdeburg.

VOLUME VIII

Editor, Charles G. Stockton, M.D.

Professor of Medicine, University of Buffalo

CONTENTS

Diseases of the Stomach. By DR. F. RIEGEL, of Giessen.

VOLUME IX

Editor, Frederick A. Packard, M.D.

Physician to the Pennsylvania Hospital and to the Children's Hospital, Philadelphia

CONTENTS

Diseases of the Liver. By DRS. H. QUINCKE and G. HOPPE-SEYLER, of Kiel.

VOLUME X

Editor, Reginald H. Fitz, A.M., M.D.

Hersey Professor of the Theory and Practice of Physic, Harvard University

CONTENTS

Diseases of the Pancreas. By DR. L. OSER, of Vienna. **Diseases of the Suprarenals.** By DR. E. NEUSSER, of Vienna.

VOLUMES IV, V, and XI

Editors announced later

Vol. IV.—**Influenza and Dengue.** By DR. O. LEICHTENSTERN, of Cologne. **Malarial Diseases.** By DR. J. MANNABERG, of Vienna.

Vol. V.—**Tuberculosis and Acute General Miliary Tuberculosis.** By DR. G. CORNET, of Berlin.

Vol. XI.—**Diseases of the Intestines and Peritoneum.** By DR. H. NOTHNAGEL, of Vienna.

CLASSIFIED LIST

OF THE

MEDICAL PUBLICATIONS

OF

W. B. SAUNDERS & COMPANY

ANATOMY, EMBRYOLOGY, HISTOLOGY.

BACTERIOLOGY.

CHARTS, DIET-LISTS, ETC.

CHEMISTRY AND PHYSICS.

CHILDREN.

DIAGNOSIS.

DICTIONARIES.

EYE, EAR, NOSE, AND THROAT.

GENITO-URINARY.

GYNECOLOGY.

HYGIENE.

MATERIA MEDICA, PHARMACOLOGY, AND THERAPEUTICS.

MEDICAL JURISPRUDENCE AND TOXICOLOGY.

NERVOUS AND MENTAL DISEASES, ETC.

NURSING.

OBSTETRICS.

PATHOLOGY.

PHYSIOLOGY.

PRACTICE OF MEDICINE.

SKIN AND VENEREAL.

SURGERY.

URINE AND URINARY DISEASES.

MISCELLANEOUS.

1. Simple
- Mechanical 1
- Chemical 2
- Thermal 3
- Electrical 4
- [illegible]
- [illegible]
- Extension 7

(2) Specific
- [illegible]
- [illegible]
- [illegible]
- [illegible]

(3) [illegible]
- [illegible]
- [illegible]

(4) General
- [illegible]
- [illegible]